Section 4

Environmental Stressors

This section describes the significant environmental stressors which impair or threaten water quality in the Flint River Basin. These include both traditional chemical stressors (such as metals or oxygen demanding waste) and less traditional stressors, such as modification of the flow regime (hydromodification) and alteration of physical habitat. Section 4.1 discusses environmental stressors by source type. Section 4.2 then provides a summary of stressor loads by type of stressor.

4.1 Sources and Types of Stressors

Environmental stressors are first catalogued by type of source in this section. This is the traditional programmatic approach, and provides a match to regulatory lines of authority for permitting and management.

4.1.1 Point Sources

Point sources constitute permitted discharges of treated wastewater to the river and its tributaries, regulated under the National Pollutant Discharge Elimination System (NPDES). These are divided into two main types: permitted wastewater discharges, which tend to discharge at relatively stable rates, and permitted stormwater discharges, which tend to discharge at highly irregular, intermittent rates, depending on precipitation. Non-discharging (land application) waste disposal facilities, which prevent discharge of wastewater effluent to surface waters, are also discussed in this section.

4.1.1.1 NPDES Permitted Wastewater Dischargers

Table 4-1 displays the major municipal wastewater treatment plants with permitted discharges of one million gallons per day (MGD) or greater in the Flint River Basin. The geographic distribution of dischargers is shown in Figure 4-1. In addition, there are discharges from a variety of smaller wastewater treatment plants, including both public facilities (schools, marinas, etc.) and private facilities (package plants associated with non-sewered developments and mobile home parks). These minor discharges may have the potential to cause localized stream impacts, but are relatively insignificant from a basin perspective.

The EPD NPDES permit program provides a basis for regulating municipal and industrial waste discharges, monitoring compliance with limitations, and appropriate enforcement action for violations. For point source discharges, the permit, among other things, establishes specific effluent limitations and specifies compliance schedules that must be met by the discharger. Effluent limitations are designed to achieve relevant numeric and narrative water quality standards in the receiving water, and are re-evaluated periodically (at least every 5 years).

Municipal wastewater treatment plants are among the most significant point sources regulated under the NPDES program in the Flint River Basin, accounting for the vast majority of the total point source effluent flow. These plants collect, treat, and release large volumes of treated wastewater. Pollutants associated with treated wastewater include pathogens, nutrients, oxygen demanding waste, metals, and chlorine residuals. Over the past several decades,

Table 4-1. Major Municipal Wastewater Treatment Facilities in The Flint River Basin

NPDES Permit #	Facility Name	City/Authority	County	Receiving Stream	Permitted Monthly Average Flow(MGD)
HUC 03130005					
GA0035777	Peachtree City Line Creek WPCP	Peachtree City	Fayette	Line Creek-Whitewater Creek	2.000
GA0035807	Fayetteville-Whitewater Creek WPCP	Fayetteville	Fayette	Whitewater Creek-Line Creek	3.750
GA0046655	Peachtree City Rockaway WPCP	Peachtree City	Fayette	Line Crk Trib. to Whitewater Crk	2.000
GA0030791	Griffin Potato Creek WPCP	Griffin	Spalding	Potato Creek trib /Flint River	2.000
GA0047040	Griffin Shoal Creek	Griffin	Spalding	Shoal Creek trib to Flint	1.500
GA0020079	Thomaston-Bell Creek WPCP	Thomaston	Upson	Bell Creek	1.500
GA0030121	Thomaston (Town Branch WPCP)	Thomaston	Upson	Potato Creek Trib to Flint	2.000
HUC 03130006					
GA0024503	Cordele WPCP	Cordele	Crisp	Gum Creek	5.000
GA0020486	Montezuma WPCP #2	Montezuma	Macon	Spring Crk/downstream of Drayton Rd	1.950
HUC 03130007					
GA0047767	Americus Mill Crk, WPCP	Americus	Sumter	Mill Crk at Muckalee Crk.	4.400
HUC 03130008					
GA0024678	Bainbridge WPCP	Bainbridge	Decatur	Flint River	2.500
GA0033511	Decatur Co-Ind. Airpark WPCP	Bainbridge	Decatur	Flint River	1.000
GA0020991	Albany	Albany	Dougherty	Flint River	20.000
GA0020362	Camilla WPCP	Camilla	Mitchell	Big Slough Crk Trib/Flint River	3.000
HUC 03130009					
GA0021326	Dawson WPCP	Dawson	Terrell	Brantley Creek	2.500
HUC 03130010					
GA0025585	Blakely WPCP	Blakely	Early	Dry Creek Trib	1.315

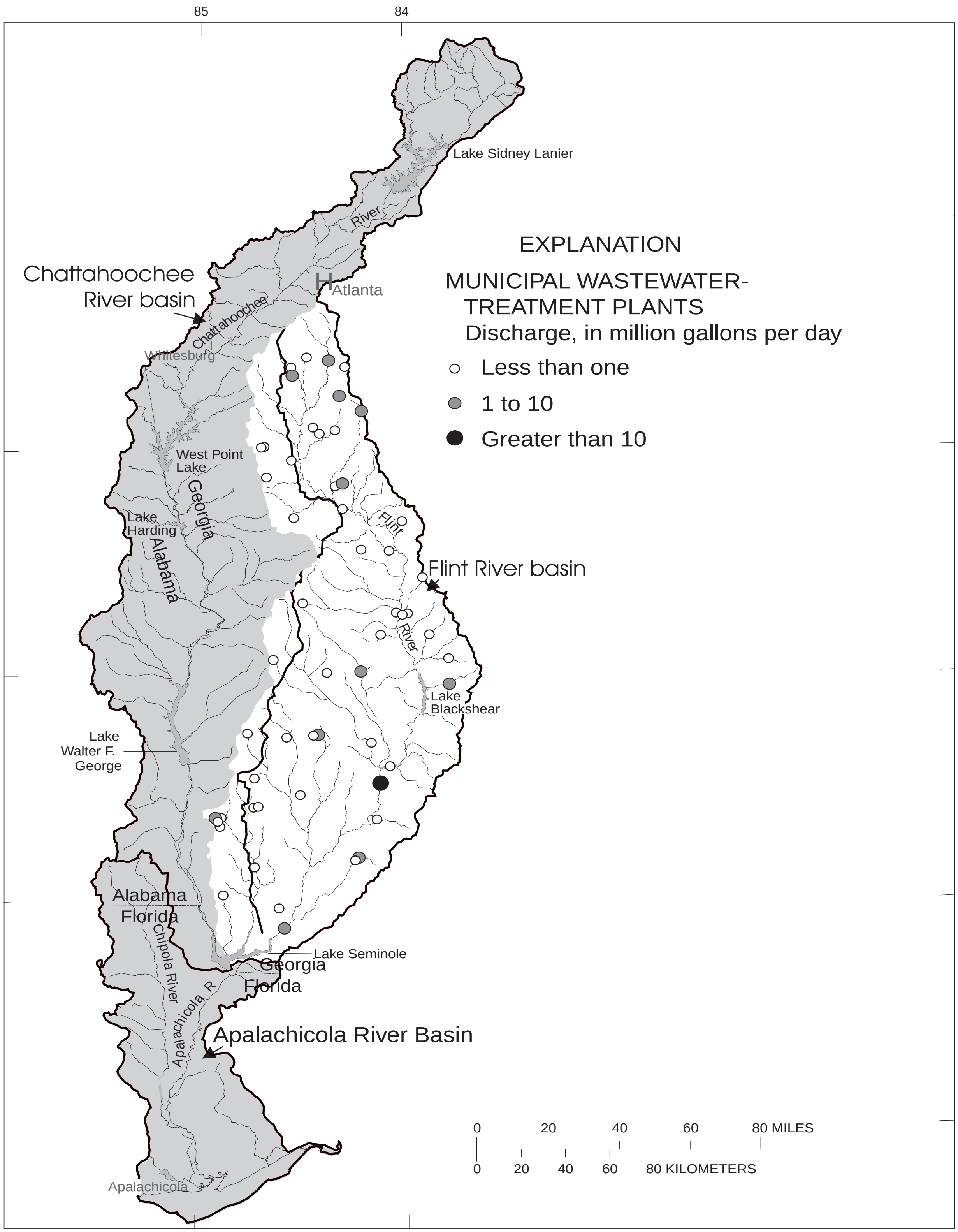

Figure 4-1. Location of Municipal Wastewater Treatment Plants in the Flint River Basin

Georgia has invested over $180,000,000 in construction and upgrade of municipal water pollution control plants in the Flint River Basin, as summarized in Appendix C. These upgrades have resulted in significant reductions in pollutant loading and consequent improvements in water quality below wastewater treatment plant outfalls. The most widely used measure of municipal pollution is the extent to which the organic content of treated wastewater depletes oxygen in the receiving water and reduces the oxygen available to fish and aquatic life. In 1994, it was estimated that approximately 93% of oxygen demanding wastes produced by municipalities was removed by municipal water pollution control plants. As of the 1994-95 water quality assessment, only 10 segments (52 miles) of river/streams in the Flint basin were identified in which municipal discharges contributed to not fully supporting designated uses, all of which are being addressed through the NPDES permitting process. A current issue in Albany is combined sewer overflows (CSOs) which have historically discharged diluted, untreated municipal wastewater during wet weather. Georgia is currently in the process of bringing all CSOs into compliance with federal and State water quality standards, as described in Section 4.1.1.2.

Most urban wastewater treatment plants also receive industrial process and non-process wastewater, which may contain a variety of conventional and toxic pollutants. Control of industrial pollutants in municipal wastewater is addressed through pretreatment programs. The major publicly-owned wastewater treatment plants in this basin have developed and implemented approved local industrial pretreatment programs. Through these programs, the wastewater treatment plants are required to establish effluent limitations for their significant industrial dischargers (those that discharge in excess of 25,000 gallons per day of process wastewater or are regulated by a Federal Categorical Standard) and to monitor the industrial user's compliance with those limits. The treatment plants are able to control the discharge of organics and metals into their sewerage system through the controls placed on their industrial users.

Industrial and federal wastewater discharges are also significant point sources regulated under the NPDES program. There are a total of 109 permitted municipal, state, federal, private, and industrial wastewater and process water discharges in the Flint River Basin, as summarized in Table 4-2. The complete permit list is summarized in Appendix D.

Only a small number of the industrial dischargers discharge significant amounts of flow. Since the nature of industrial discharges varies widely compared to discharges from municipal plants, effluent flow is not generally a good measure of the significance of an industrial discharge. Industrial discharges can consist of organic heavy oxygen-demanding waste loads from facilities

Table 4-2. Summary of NPDES Permits in the Flint River Basin

HUC	Major Municipal	Small Public and Private Facilities	Industrial and Federal Facilities	Total
03130005	7	24	12	43
03130006	2	7	5	14
03130007	1	7	2	10
03130008	4	4	11	19
03130009	1	8	0	9
03130010	1	4	0	5

such as pulp and paper mills, large quantities of non-contact cooling water and very little else from facilities such as power plants, pit pumpout and surface runoff from mining and quarrying operations where the principal source of pollutants is the land disturbing activity rather than the addition of any chemicals or organic materials, or complex mixtures of organic and inorganic pollutants from chemical manufacturing, textile processing, metal finishing, etc. Pathogens and chlorine residuals are rarely of concern with industrial discharges, but other conventional and toxic pollutants must be addressed on a case-by-case basis through the NPDES permitting process. As of the 1994-95 water quality assessment, six (6) segments (47 miles) of river/streams were identified in which industrial discharges contributed to not supporting designated uses, all of which are being addressed through the NPDES permitting process. Table 4-3 lists the four major industrial and federal wastewater treatment plants with discharges into the Flint River Basin in Georgia. There are also 50 minor industrial discharges which may have the potential to cause localized stream impacts, but are relatively insignificant from a basin perspective.

The locations of permitted point source discharges of treated wastewater in the Flint River Basin are shown in Figures 4-2 through 4-7.

4.1.1.2 Combined Sewer Overflows (CSO)

Combined sewers are sewers that carry both stormwater runoff and sanitary sewage in the same pipe. Most of these combined sewers were built at the turn of the century and are found in most large cities. At that time both sewage and stormwater runoff were piped from the buildings and streets to the small streams that originated in the heart of the city. When these streams were enclosed in pipes, they became today's combined sewer systems. As the cities grew, their combined sewer system expanded. Often new combined sewers were laid in order to move the untreated wastewater discharge to the outskirts of the town.

In later years, wastewater treatment facilities were built and smaller sanitary sewers were constructed to carry the sewage (dry weather flows) from the termination of the combined sewers to these facilities for treatment. However during wet weather when significant stormwater is carried in the combined system, the sanitary sewer capacity is exceeded and a combined sewer overflow (CSO) occurs. The surface discharge is a mixture of stormwater and sanitary waste. Uncontrolled CSOs thus discharge diluted raw sewage, and can introduce elevated concentrations of bacteria, BOD, and solids into a receiving water body. In many cases, CSOs discharge into relatively small creeks, where the effects can be devastating. CSOs are considered point sources of pollution and are subject to the requirements of the Clean Water Act. Although CSOs are not required to meet secondary treatment effluent limits, sufficient

Table 4-3. Major Industrial and Federal Wastewater Treatment Facilities in the Flint River Basin

NPDES Permit #	Facility Name	County	Receiving Stream
HUC 03130005			
GA0000213	Thomaston Mills Inc	Upson	Fourth Br
HUC 03130006			
GA0049336	Weyerhauser	Macon	Flint River
HUC 03130008			
GA0001465	Georgia Power Plant Mitchell	Dougherty	Flint River
GA0001619	Merck Manufacturing Division	Dougherty	Flint River

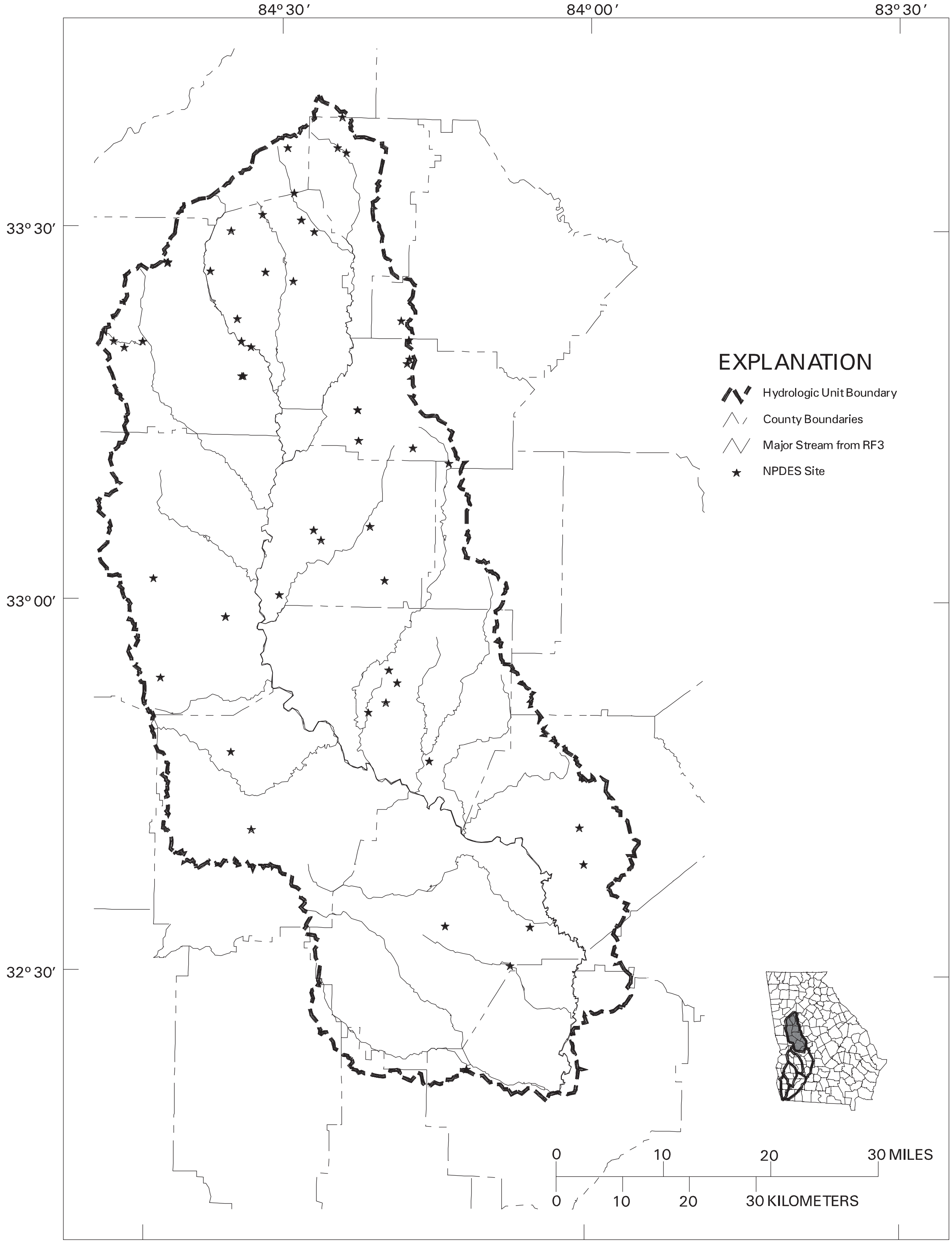

Figure 4-2. NPDES Sites Permitted by EPD, Upper Flint River Basin, HUC 03130005

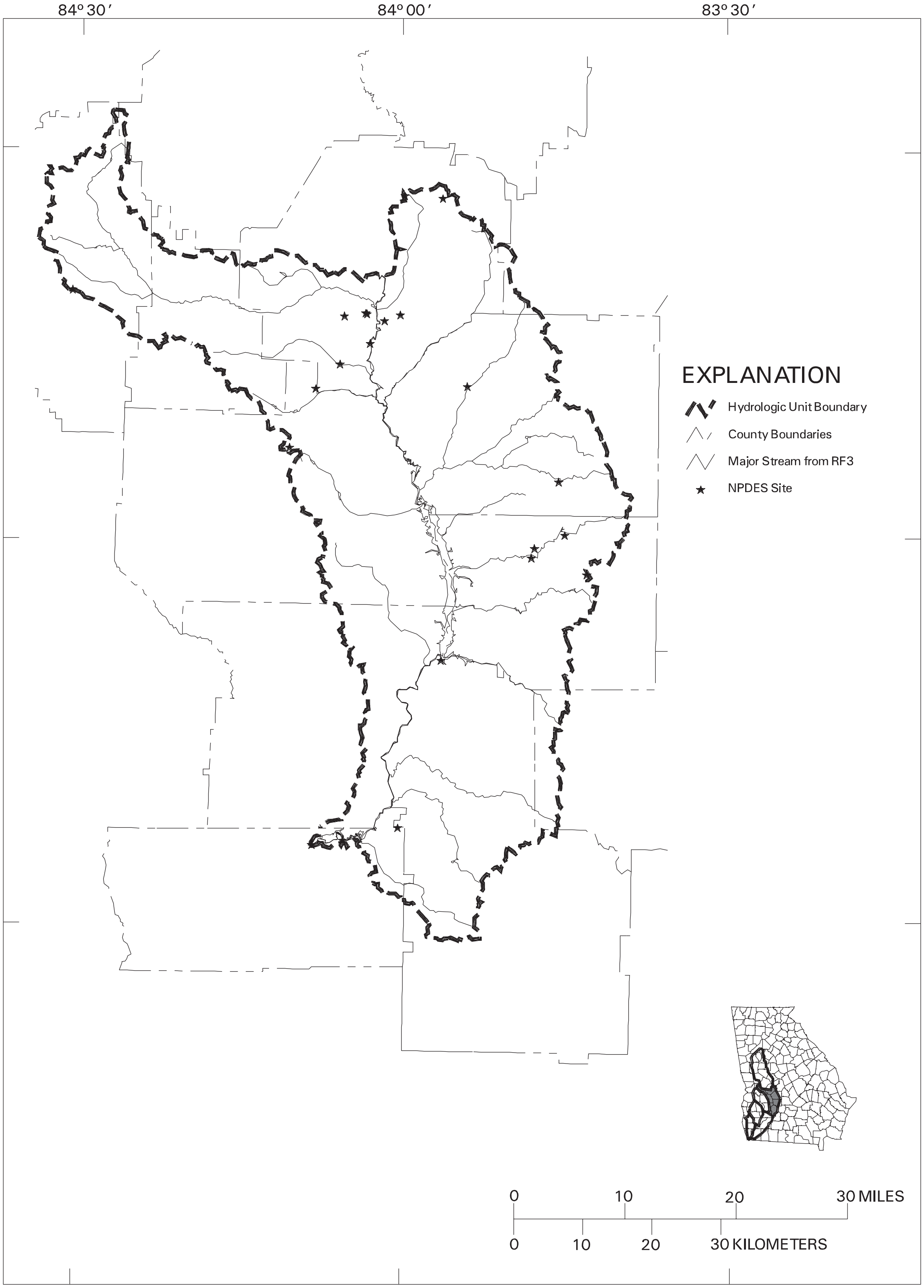

Figure 4-3. NPDES Sites Permitted by EPD, Middle Flint River Basin, HUC 03130006

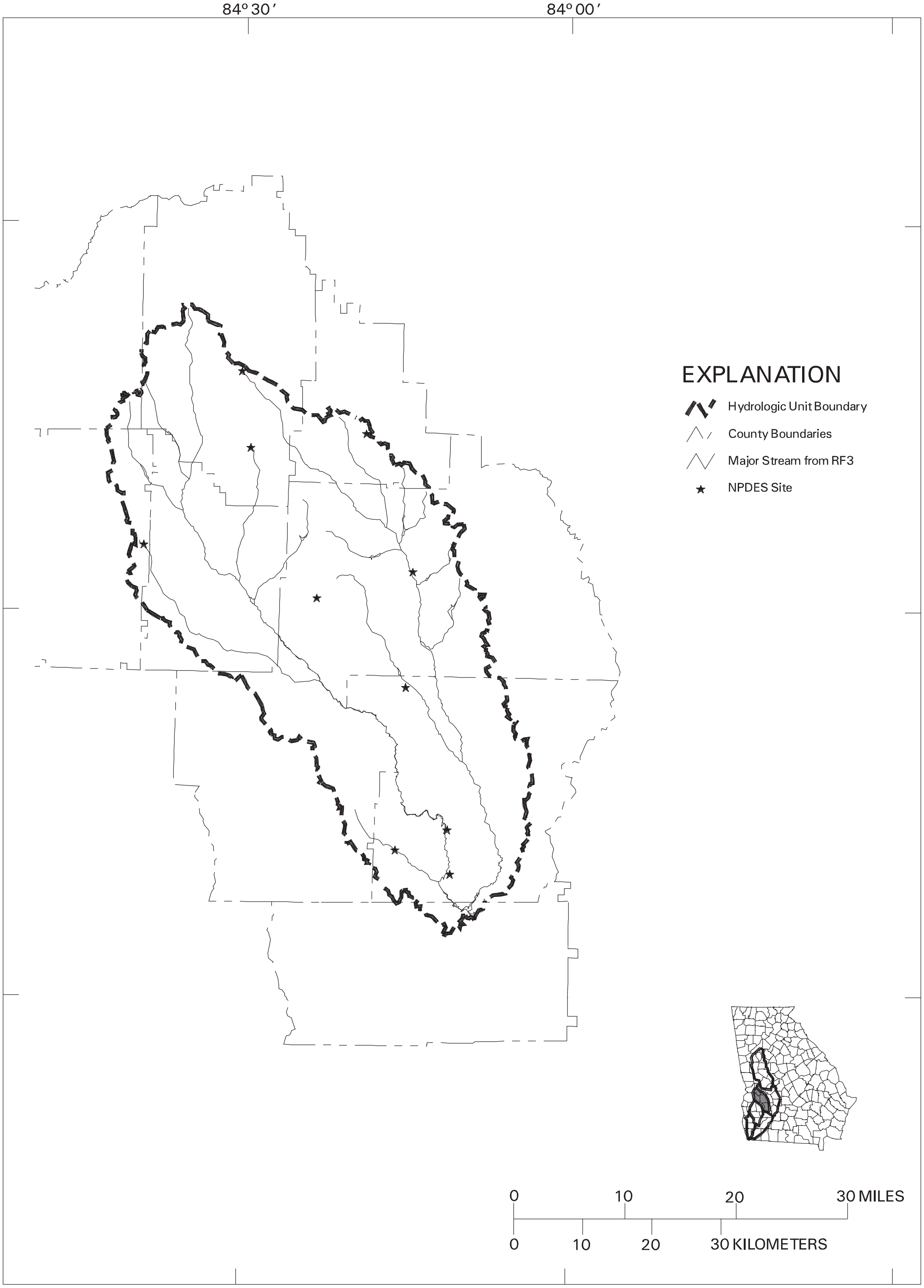

Figure 4-4. NPDES Sites Permitted by EPD, Kinchafoonee-Muckalee Creeks Basins, HUC 03130007

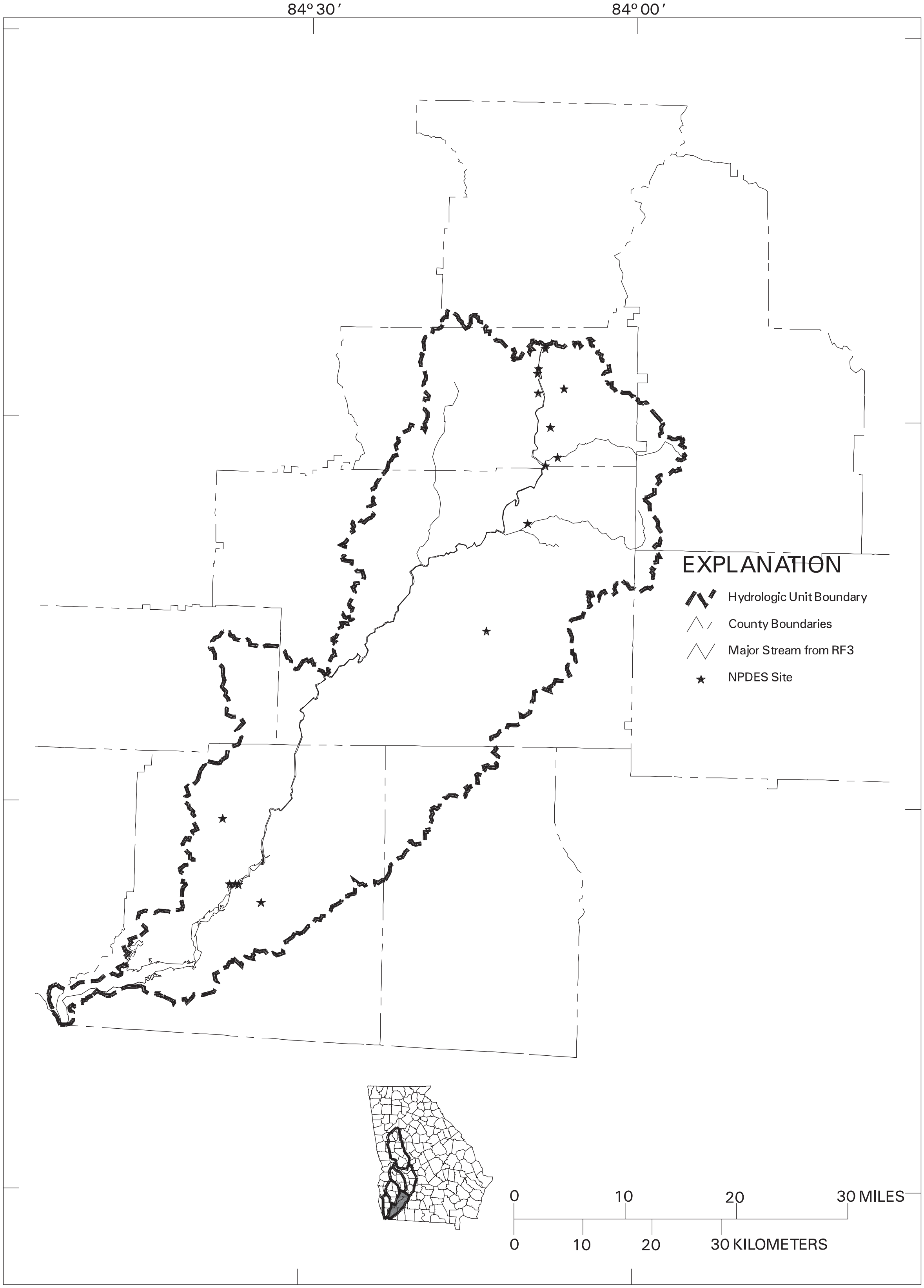

Figure 4-5. NPDES Sites Permitted by EPD, Lower Flint River Basin, HUC 03130008

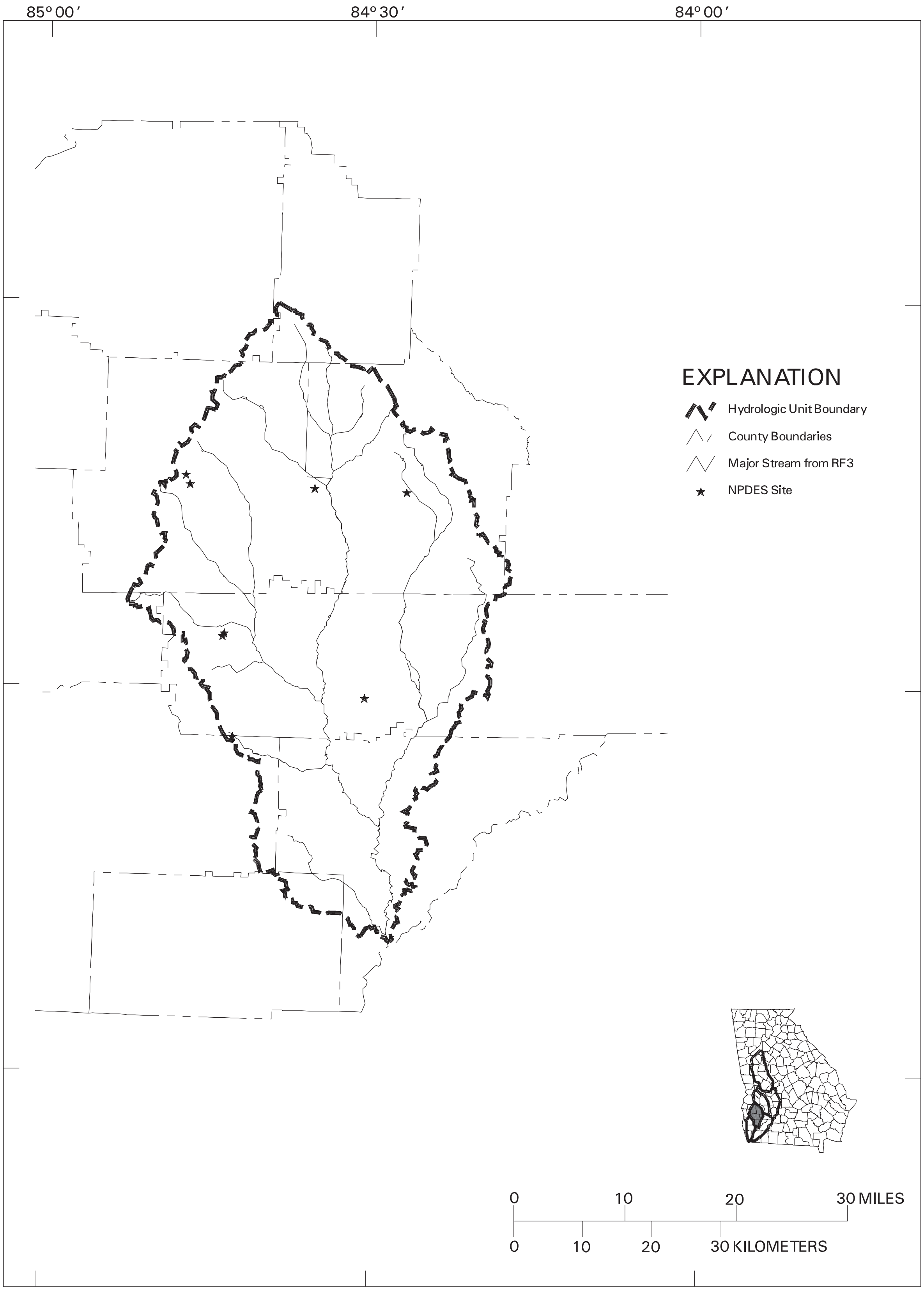

Figure 4-6. NPDES Sites Permitted by EPD, Ichawaynochaway Creeks Basins, HUC 03130009

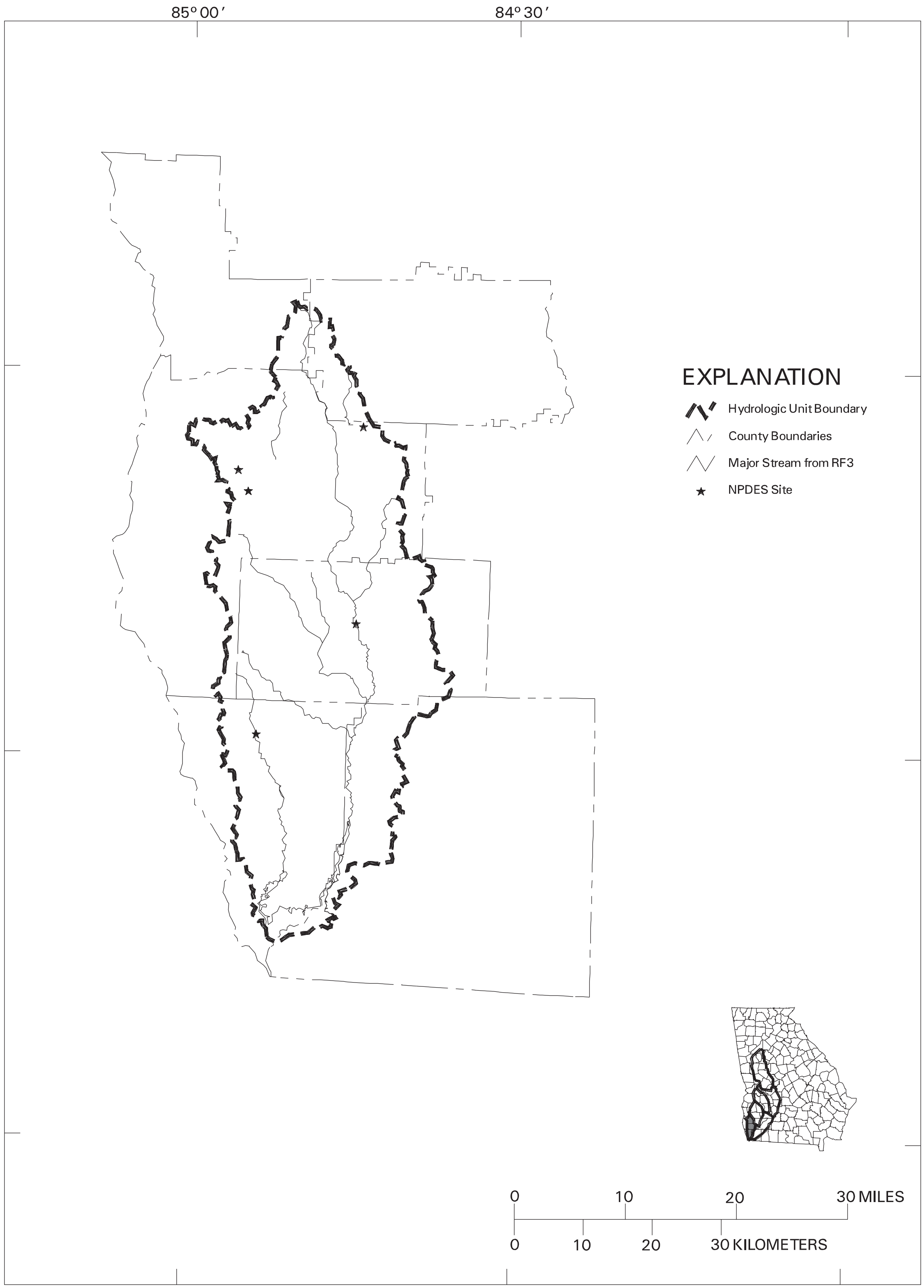

Figure 4-7. NPDES Sites Permitted by EPD, Spring Creek Basin, HUC 03130010

controls are required to protect water quality standards for the designated use of the receiving stream.

In the 1990 session of the Georgia Legislature, a CSO law was passed requiring all Georgia cities with CSOs to eliminate or treat CSOs. Albany is the only city in the Flint River Basin that has combined sewer systems. Following the 1990 legislation, the City of Albany conducted a study to locate and determine the impact of CSOs on the Flint River.

Although CSO controls are well underway in the Flint River Basin, there is very limited data on the overall effectiveness of the controls and resulting improvement to water quality. The next basin planning cycle should provide more information on the effects of CSO mitigation on water quality of the Flint River Basin. Table 4-4 lists twelve active CSOs that were identified in the City of Albany.

The City's plan calls for controlling more than 75% of the CSO discharge during approximately 95% of the storms by transport and treatment at the City's wastewater treatment facility. The total costs of the interceptors, separation, diversion, storage and treatment facility expansion is over $40 million.

Much of the work involved in the plan has been completed. However, due to the 1994 flood some work has been delayed. The complete control plan should be in operation, including the expansion of the treatment facility, in late 1998.

4.1.1.3 NPDES Permitted Stormwater Discharges

Urban stormwater has been identified as a major source of stressors such as oxygen demanding waste (BOD) and fecal coliforms in the Upper Flint River Basin, due to metropolitan Atlanta. Stormwater may flow directly to streams as a diffuse, non-point source process, or may be collected and discharged through a storm sewer system. Storm sewers are now subject to NPDES permitting and are discussed in this section. Nonpoint stormwater is discussed in Section 4.1.2.2.

Pollutants typically found in urban stormwater runoff include pathogens (such as bacteria and viruses from human and animal waste), heavy metals, debris, oil and grease, petroleum hydrocarbons, and a variety of compounds toxic to aquatic life. In addition, the runoff often contains sediment, excess organic material, fertilizers (particularly nitrogen and phosphorus compounds), herbicides, and pesticides, which can upset the natural balance of aquatic life in lakes and streams. All of these pollutants, and many others, influence the quality of stormwater runoff. There are also many problems related to the quantity of urban runoff, which contributes to flooding and erosion in the immediate drainage area and downstream.

Table 4-4. Albany CSOs in the Flint River Basin

8th Avenue	Highland Avenue
3rd Avenue	Whitney Avenue
3rd Avenue West	Lift Station # 27
Booker Avenue	East Side/N. Broadway Avenue
West Broad Avenue	East Side/S. CSX Railroad
Oglethorpe Bridge	Mercer Avenue

In accordance with Federal "Phase I" stormwater regulations, the State of Georgia has issued individual area-wide NPDES municipal separate storm sewer system (MS4) permits to 58 cities and counties in municipal areas with populations greater than 100,000 persons. Only one of these permits falls within the Flint basin, as shown in Table 4-5.

Industrial sites often have their own stormwater conveyance systems. Volume and quality of stormwater discharges associated with industrial activity is dependent upon a number of different factors, such as the industrial activities occurring at the facility, the nature of precipitation, and the degree of surface imperviousness. These discharges are of intermittent duration with short-term pollutants loadings that can be high enough to have shock loading effects on the receiving waters. The types of pollutants from industrial facilities are generally similar to those found in stormwater discharges from commercial and residential sites; however, industrial facilities have a significant potential for discharging at higher pollutant concentrations, and may include specific types of pollutants associated with a given industrial activity.

EPD has issued one general permit regulating stormwater discharges for 10 of 11 federally regulated industrial subcategories. The 11th subcategory, construction activities, will be covered under a separate general permit. The general permit for industrial activities requires the submission of a Notice of Intent (NOI) for coverage under the general permit; the preparation and implementation of a stormwater pollution prevention plan; and, in some cases, the monitoring of stormwater discharges from the facility. As with the municipal stormwater permits, implementation of site-specific best management practices is the preferred method for controlling stormwater runoff.

4.1.1.4 Non-Discharging Waste Disposal Facilities

Land Application Systems (LAS)

In addition to permits for point source discharges, EPD has developed and implemented a permit system for land application systems. Land application systems for final disposal of treated wastewaters have been encouraged in Georgia, and are designed to eliminate surface discharges of effluent to waterbodies. Land application systems are used as alternatives to advanced levels of treatment or as the only alternative in some environmentally sensitive areas.

When properly operated, a LAS should not be a source of stressors to surface waters. Their locations are, however, worth noting because of the (small) possibility that a LAS could malfunction and become a source of stressor loading.

Table 4-5. Permitted Municipal Separate Storm Sewer System, Flint River Basin

Permit #	GAS000130	**Contact**	Mary Lee, Mayor
Permittee	Riverdale	**Address**	6690 Church Street
County	Clayton	**City**	Riverdale
Type	Large/Clayton Coapp	**ZIP**	30274
Issued	06/15/94		
Expires	06/14/99		
HUC	03130005		

A total of 128 (municipal) and 35 (industrial) permits for land application systems were in effect in Georgia in 1995. Municipal and other wastewater land application systems within the Flint basin are listed in Table 4-6. The locations of all LAS's within the basin are shown in Figures 4-8 through 4-13.

Landfills

Permitted landfills are required to contain and treat any leachate or contaminated run-off prior to discharge to any surface water. The permitting process encourages either direct connection to a publicly-owned treatment works (although vehicular transportation is allowed in certain cases) or treatment and recirculation on-site to achieve a no-discharge system. Direct discharge in compliance with NPDES requirements is allowed but not currently practiced at any landfills in Georgia. Groundwater contaminated by landfill leachate from older, unlined landfills represents a potential threat to waters of the State. Groundwater and surface water monitoring and corrective action requirements are in place for all landfills operated after 1988 to identify

Table 4-6. Wastewater Land Application Systems in the Flint Basin

Facility Name	Facility Number	County	Design Flow (MGD)
HUC 03130005			
Clayton Co. Shoal Creek	GAU 020236	Clayton	1.10
Fayette Co (CR Edu.Complx)	GAU 030898	Fayette	0.15
Hampton Industrial Park	GAU 020125	Henry	0.10
Henry Co. Bear Creek	GAU 020095	Henry	0.25
Manchester	GAU 020081	Meriwether	0.81
Southern Mills, Inc.	GAU 010311	Coweta	0.07
Southern Mills, Inc.	GAU 010578	Upson	0.50
Upson Co. - C.I.	GAU 020136	Upson	0.008
Woodbury	GAU 020079	Meriwether	0.32
HUC 03130006			
Southern Dairy	GAU 010410	Macon	0.233
Southern Dairy	GAU 010409	Macon	0.415
Tyson Foods	GAU 010457	Macon	0.048
Vienna	GAU 020244	Dooly	0.75
Vienna	GAU 020167	Dooly	0.99
HUC 03130007			
GDC - Lee C.I.	GAU 020284	Lee	0.07
Oak Hill Farms	GAU 010455	Lee	0.236
HUC 03130008			
Camilla	GAU 020088	Mitchell	3.10
Mitchell Co.-Autry C. I.	GAU 030740	Mitchell	0.145
United States Dairy Co.	GAU 010558	Mitchell	0.318
HUC 03130009			
Georgia Feed Products, Inc.	GAU 010509	Randolph	0.345
Morgan - Calhoun C. I.	GAU 020076	Calhoun	0.15
HUC 03130010			
None			

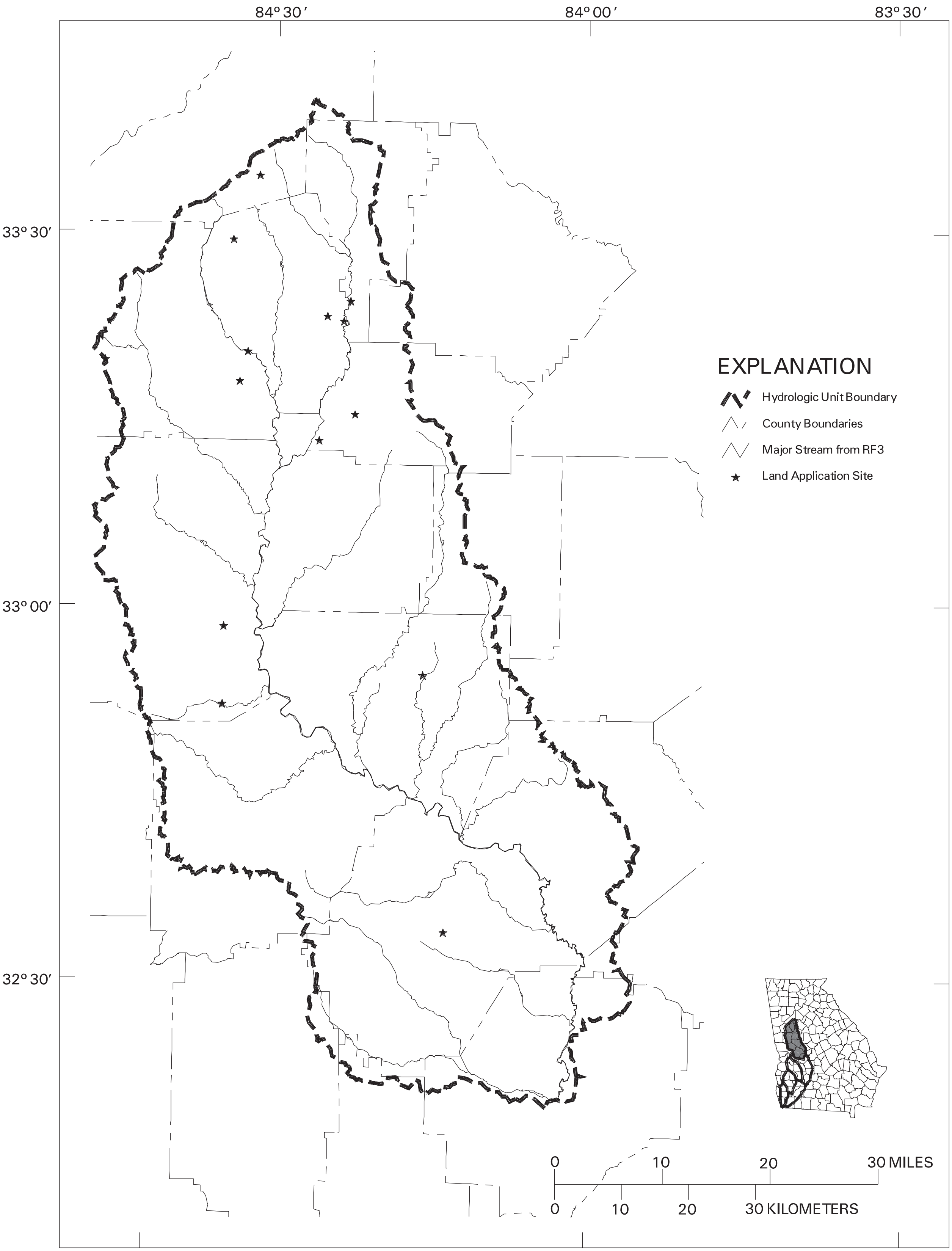

Figure 4-8. Land Application Sites, Upper Flint River Basin, HUC 03130005

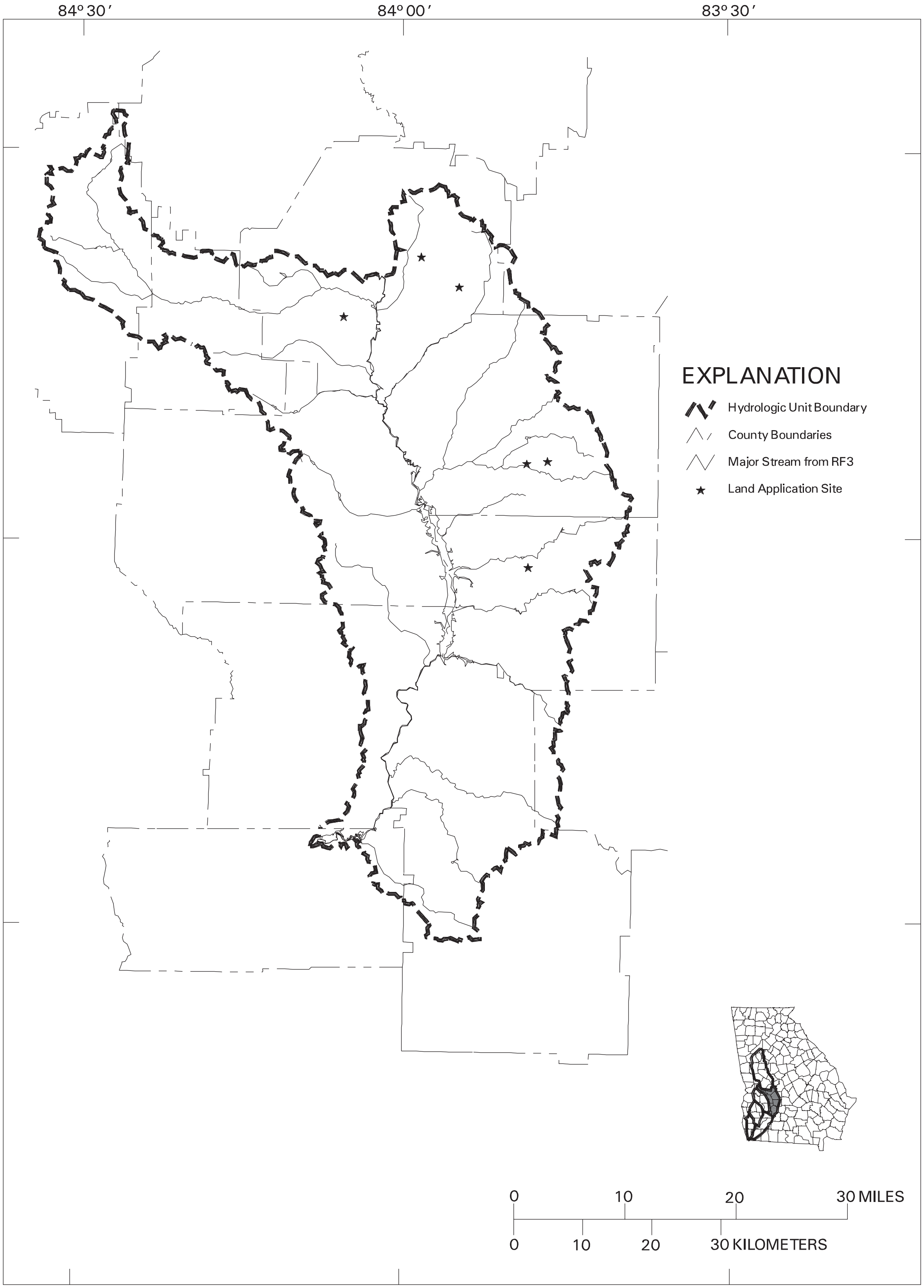

Figure 4-9. Land Application Sites, Middle Flint River Basin, HUC 03130006

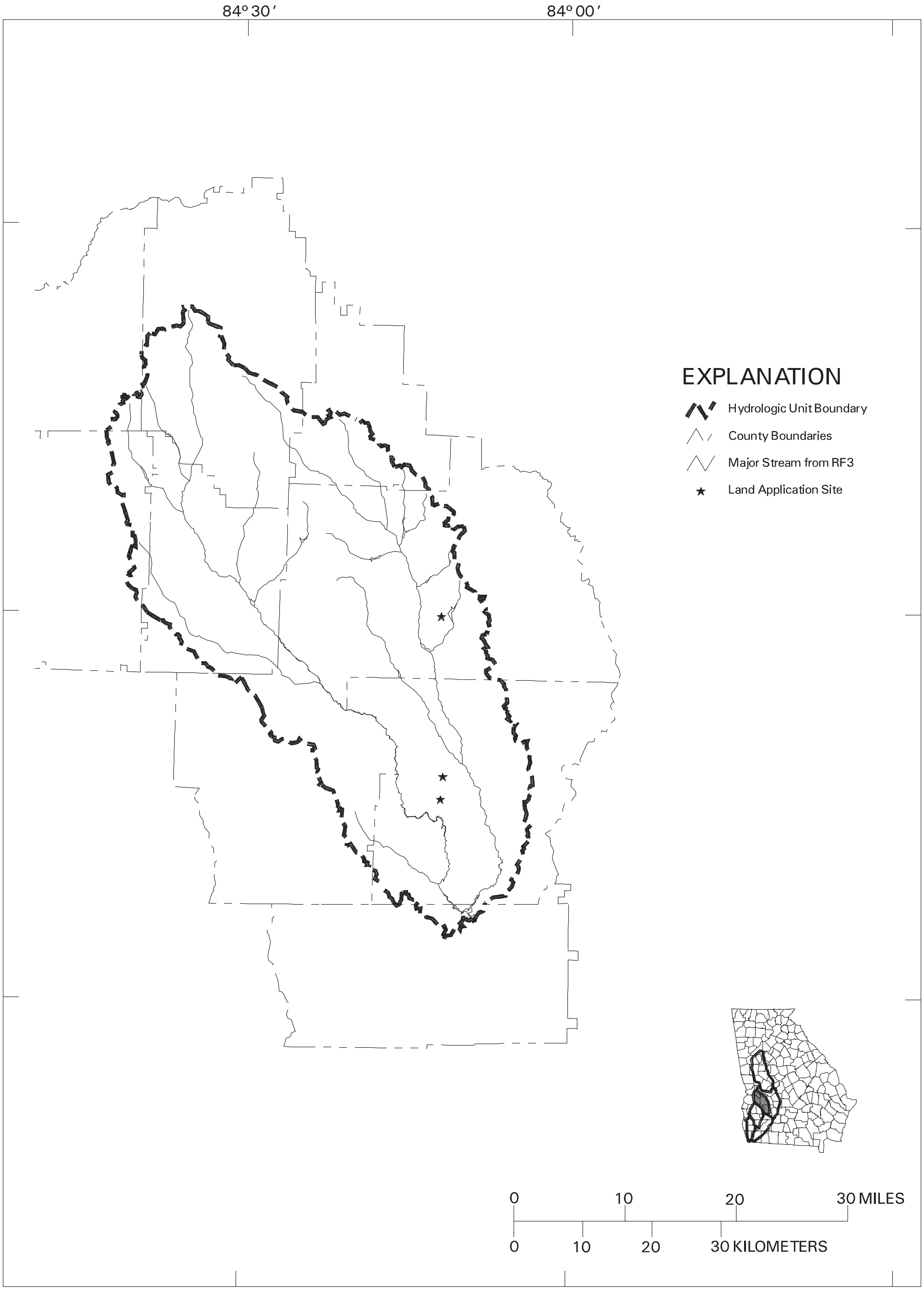

Figure 4-10. Land Application Sites, Kinchafoonee-Muckalee Creeks Basin, HUC 03130007

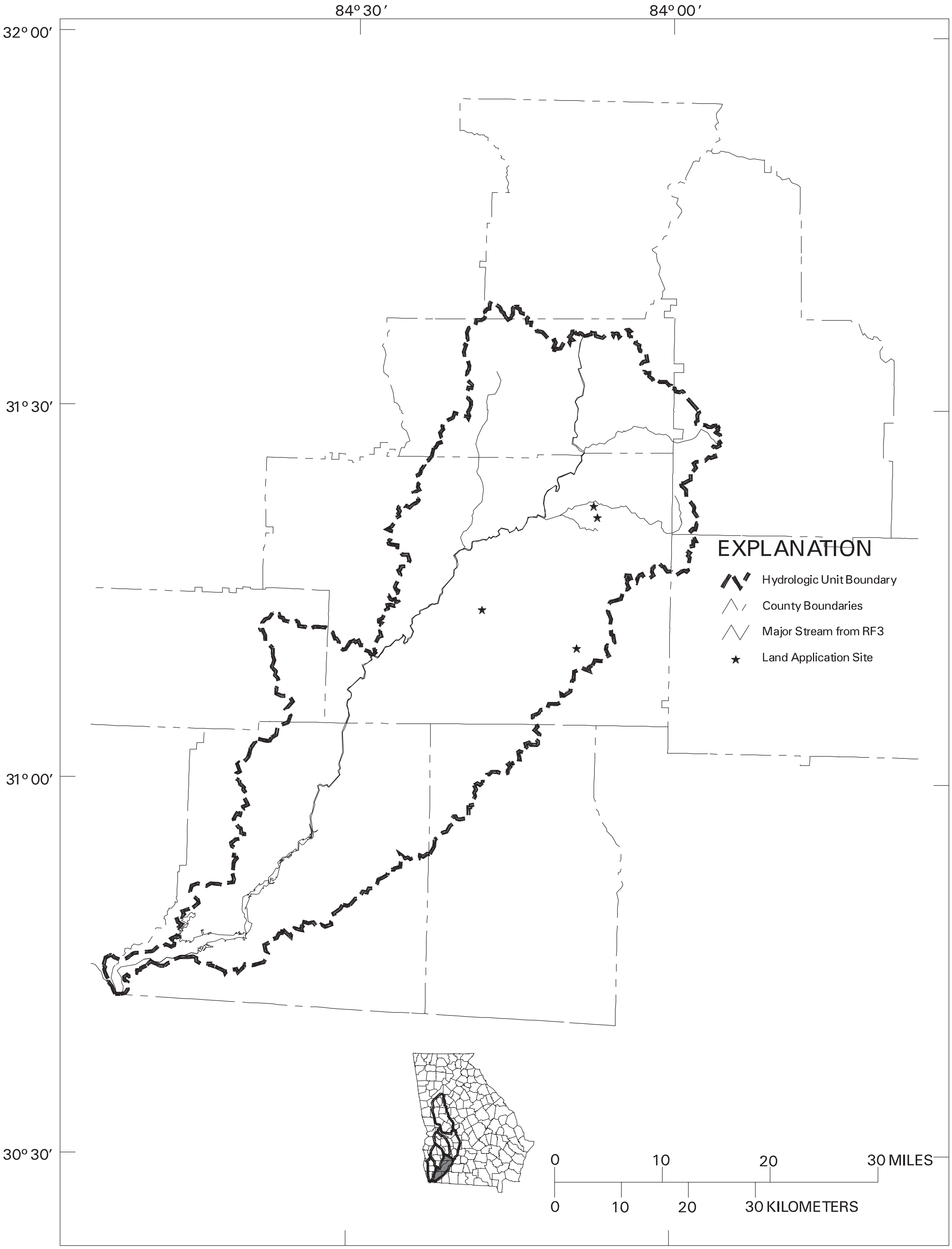

Figure 4-11. Land Application Sites, Lower Flint River Basin, HUC 0313008

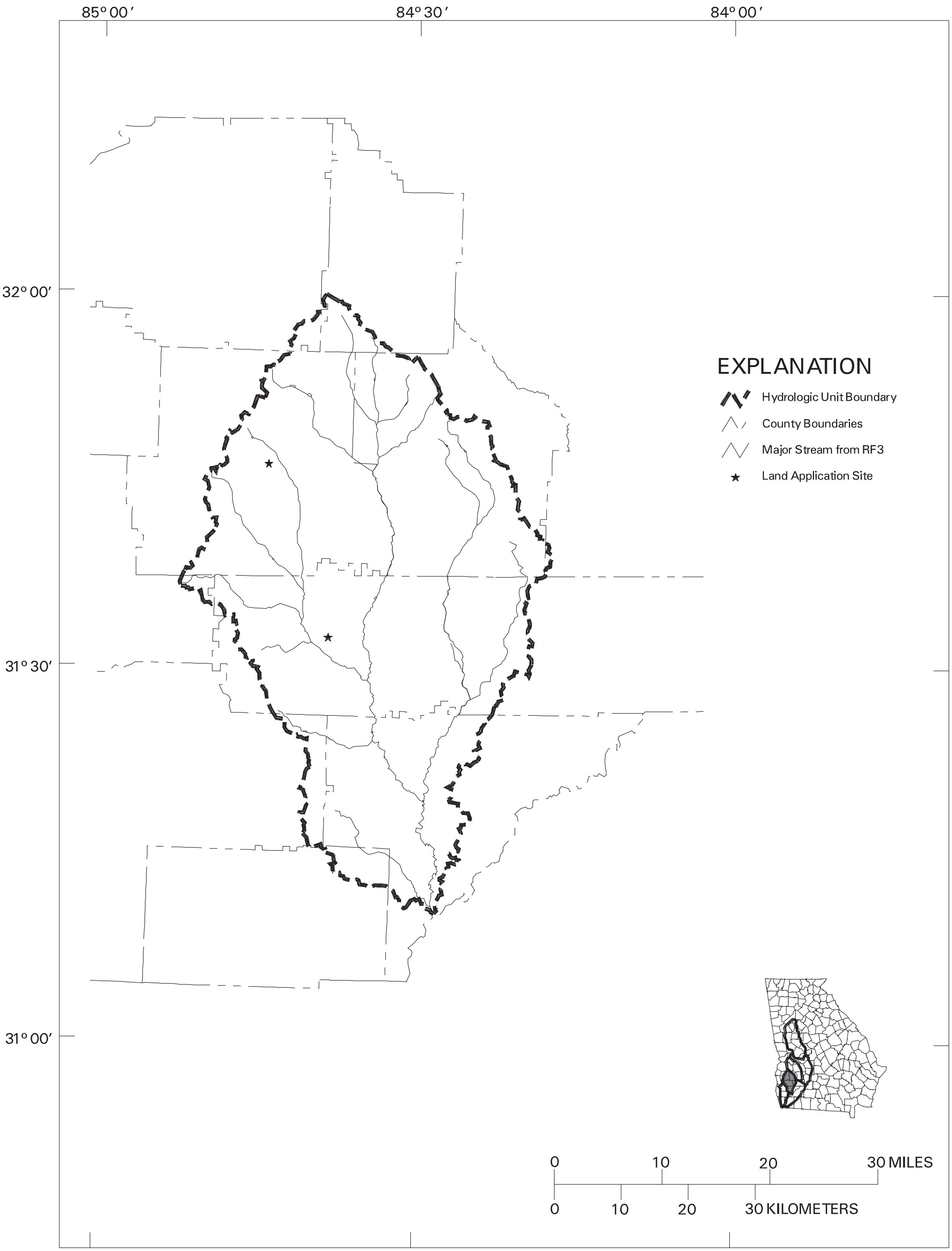

Figure 4-12. Land Application Sites, Ichawaynochaway Creek Basin, HUC 03130009

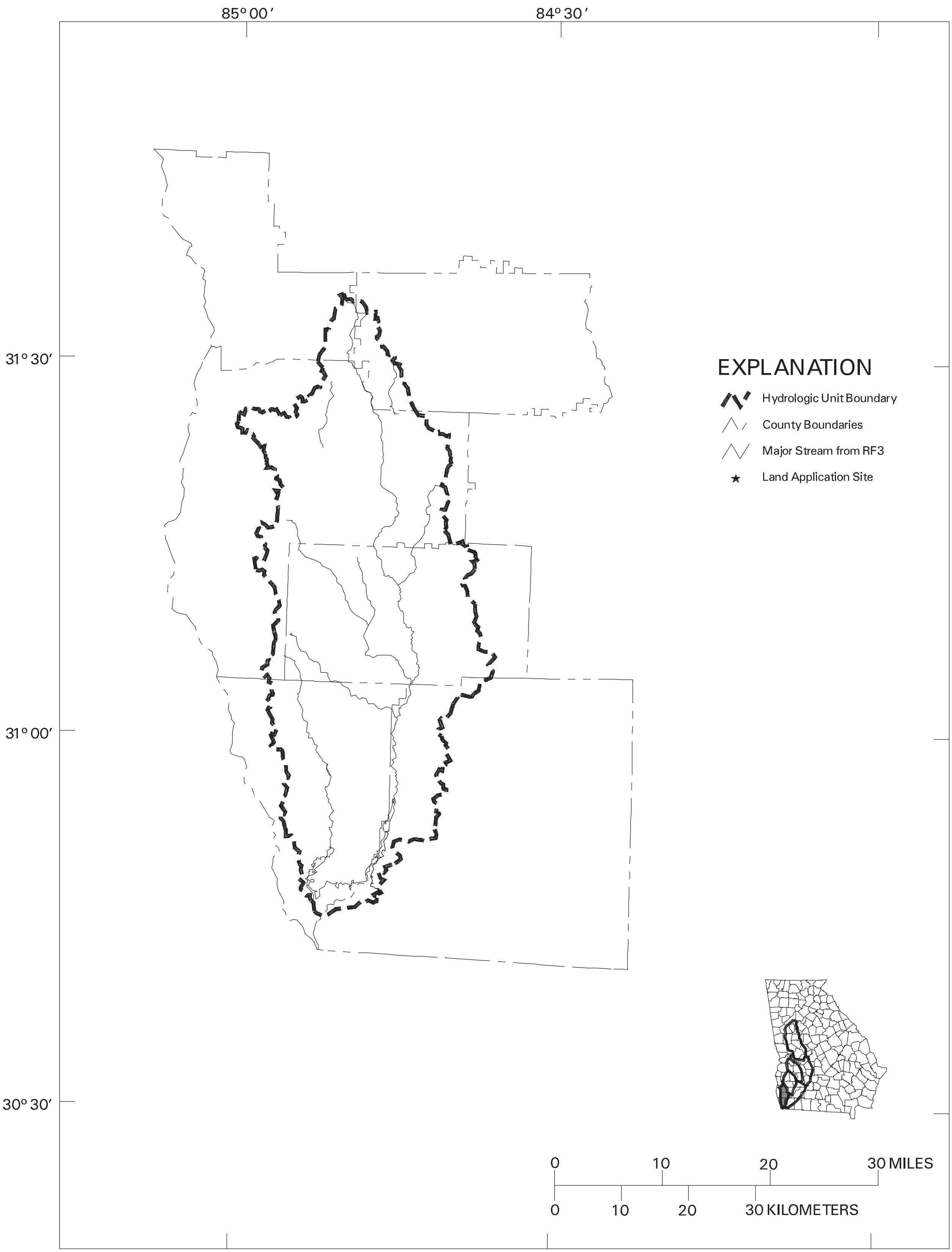

Figure 4-13. Land Application Sites, Spring Creek Basin, HUC 03130010

and remediate potential threats. Provisions of the Hazardous Sites Response Act address threats posed by older landfills as releases of hazardous constituents are identified. All new municipal solid waste landfills are required to be lined and have a leachate collection system installed.

EPD's Land Protection Branch is responsible for permitting and compliance of municipal and industrial Subtitle D landfills. The location of permitted landfills within the basin is shown in Figures 4-14 through 4-19.

4.1.2 Nonpoint Sources

The pollution impact on Georgia's streams has shifted over the last two decades. Streams are no longer dominated by untreated or partially treated wastewater discharges which result in little or no oxygen and little or no aquatic life. The wastewater is now treated, oxygen levels have returned, and strong fisheries have followed. Industrial discharges have also been placed under strict regulation. However, other sources of pollution are still affecting Georgia's streams. These sources are referred to as nonpoint, and consist of mud, litter, bacteria, pesticides, fertilizers, metals, oils, grease, and a variety of other pollutants which are washed from rural and urban lands by stormwater.

Nonpoint pollutant loading comprises a wide variety of sources not subject to point source control via NPDES permits. The most significant nonpoint sources are those associated with precipitation, washoff, and erosion, which may move pollutants from the land surface to water bodies. Both rural and urban land uses can contribute significant amounts of nonpoint pollution.

Historically in Georgia, as well as elsewhere in the nation, the major source of water quality degradation has been pollutant loading from point sources. However, as the dominant point source problems have been brought under control, increasing emphasis has been placed on the control of nonpoint source pollution. A review of 1994-95 water quality assessment results for the Flint River Basin indicate that urban runoff and nonpoint sources contribute significantly to nonsupport of water uses.

4.1.2.1 Nonpoint Sources from Agriculture

Agricultural operations can contribute stressors to water bodies in a variety of ways. Tillage and other soil disturbing activities may promote erosion and loading of sediment to water bodies, unless controlled by management practices. Nutrients contained in fertilizers, animal wastes, or natural soils may be transported from agricultural land to streams in either sediment-attached or dissolved forms. Loading of pesticides and pathogens is also of concern for various agricultural operations.

Agricultural influences on aquatic ecosystems differ with the type of agricultural activity. Confined feeding for poultry and livestock production dominate in the Piedmont Province, and row-crop agriculture dominates in the Coastal Plain. Potential effects on aquatic ecosystems in the Piedmont Province primarily are nutrient enrichment from manure disposal and riparian degradation and stream-bank erosion caused by livestock trampling and grazing. Aquatic ecosystems in areas of row-crop agriculture are at risk of receiving inputs of pesticides and chemical fertilizers.

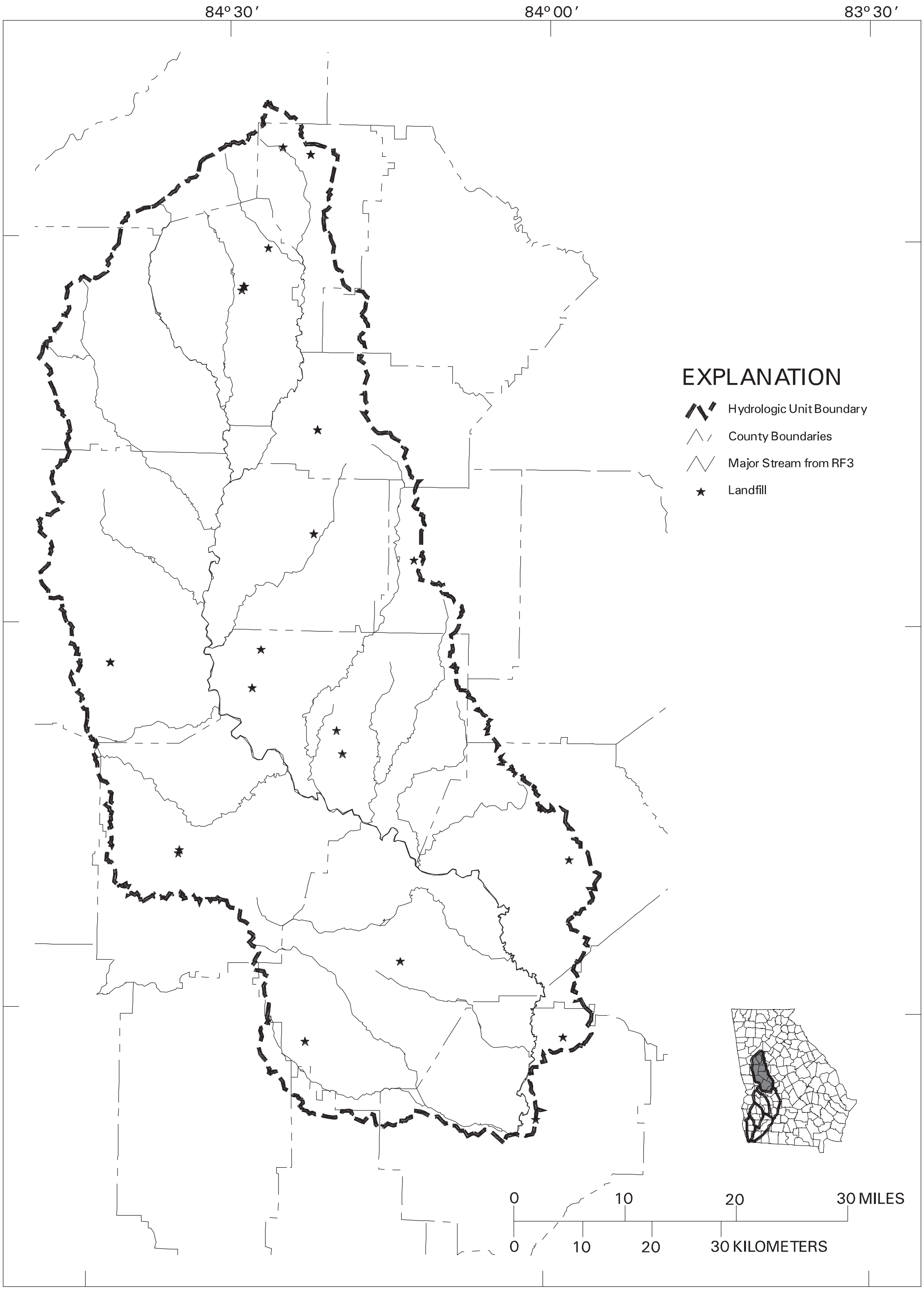

Figure 4-14. Landfills, Upper Flint River Basin, HUC 0313005

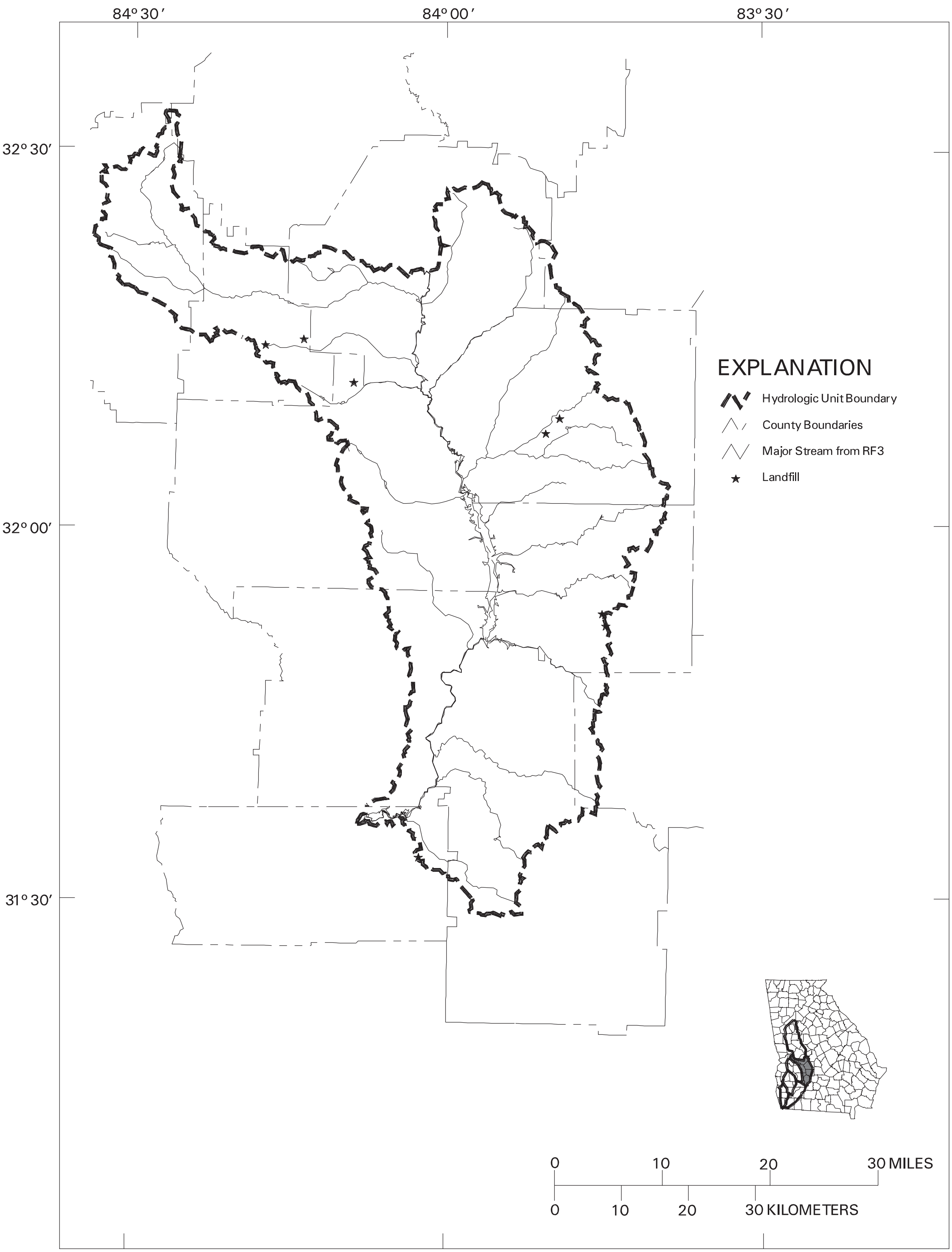

Figure 4-15. Landfills, Middle Flint River Basin, HUC 03130006

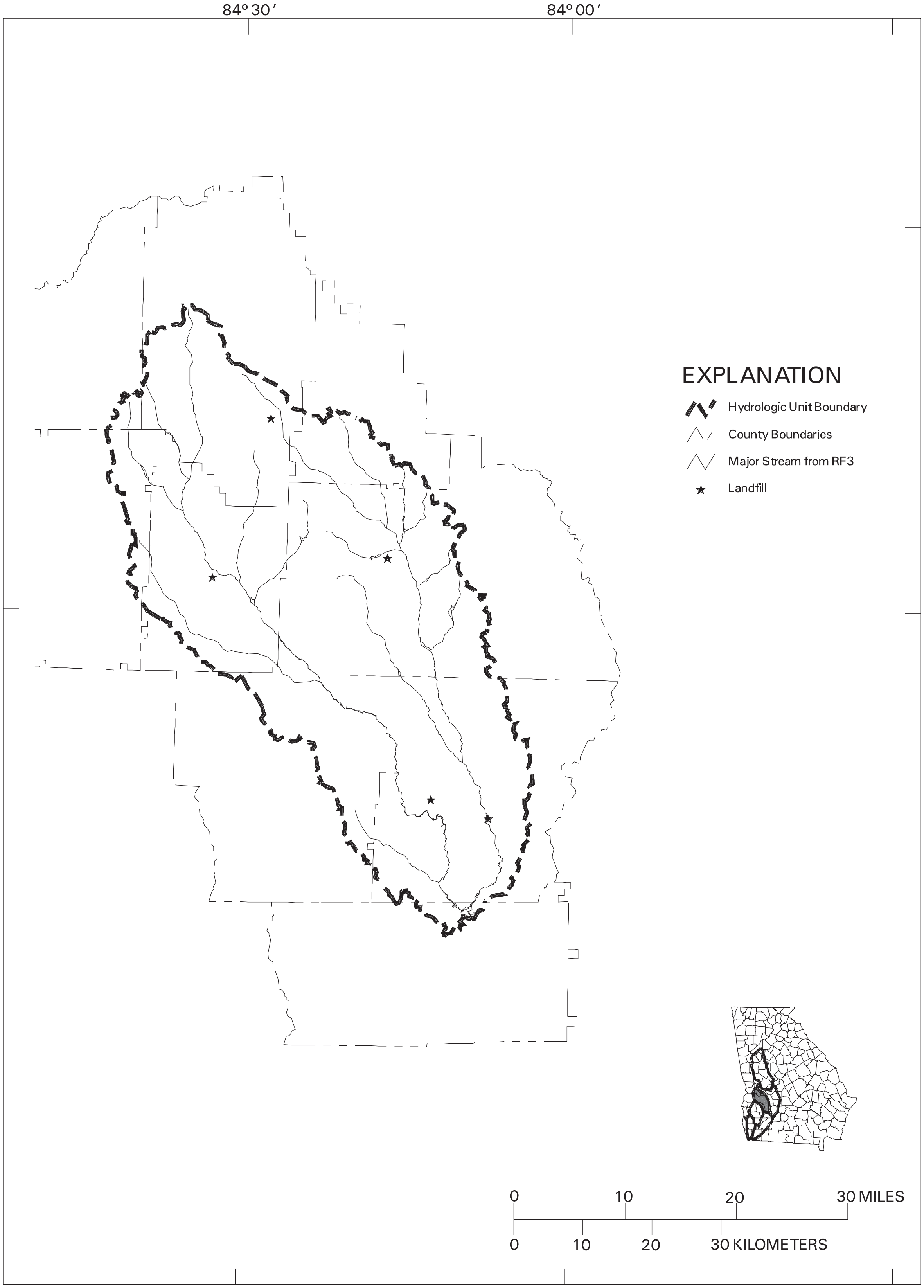

Figure 4-16. Landfills, Kinchafoonee-Muckalee Creeks Basin, HUC 03130007

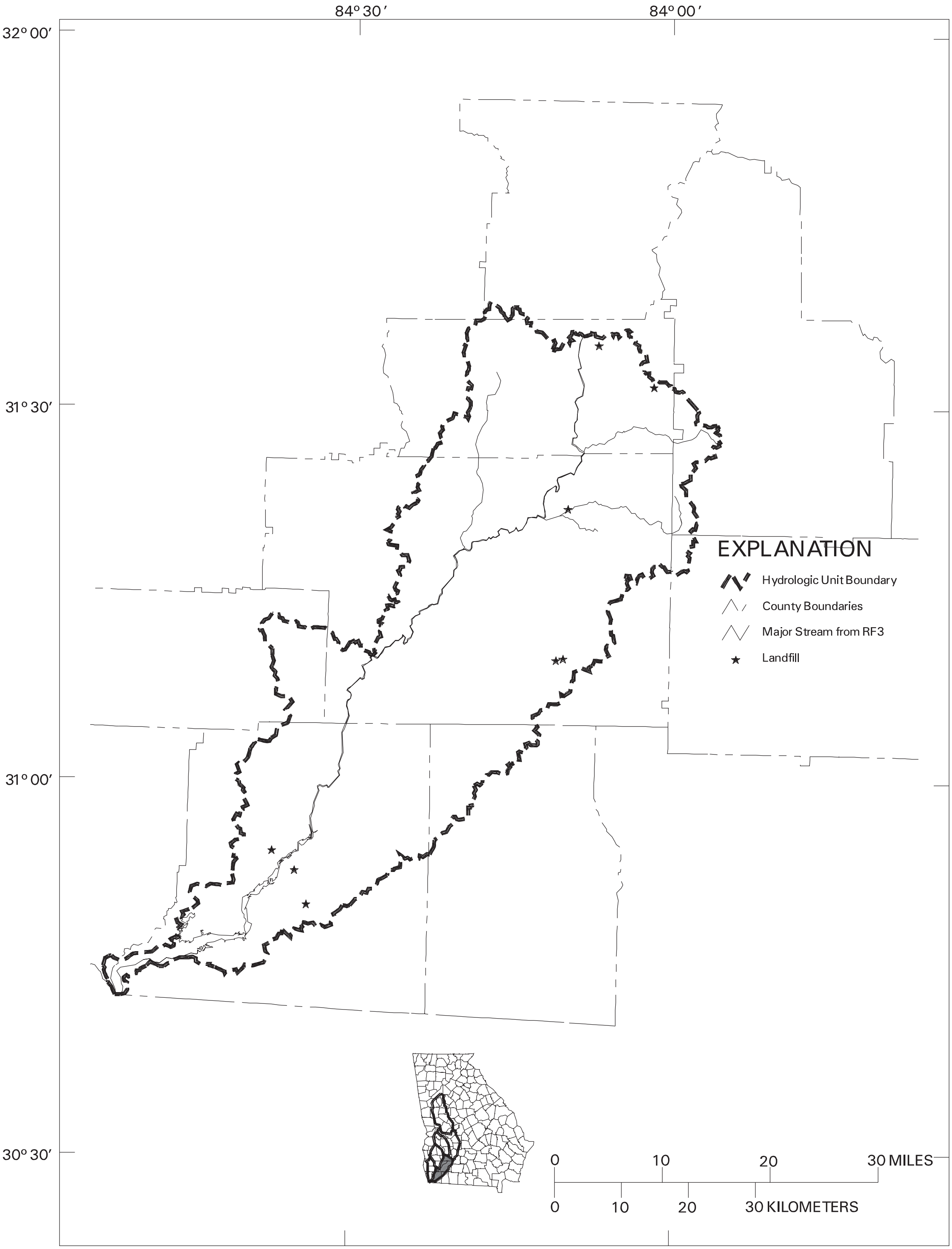

Figure 4-17. Landfills, Lower Flint River Basin, HUC 03130008

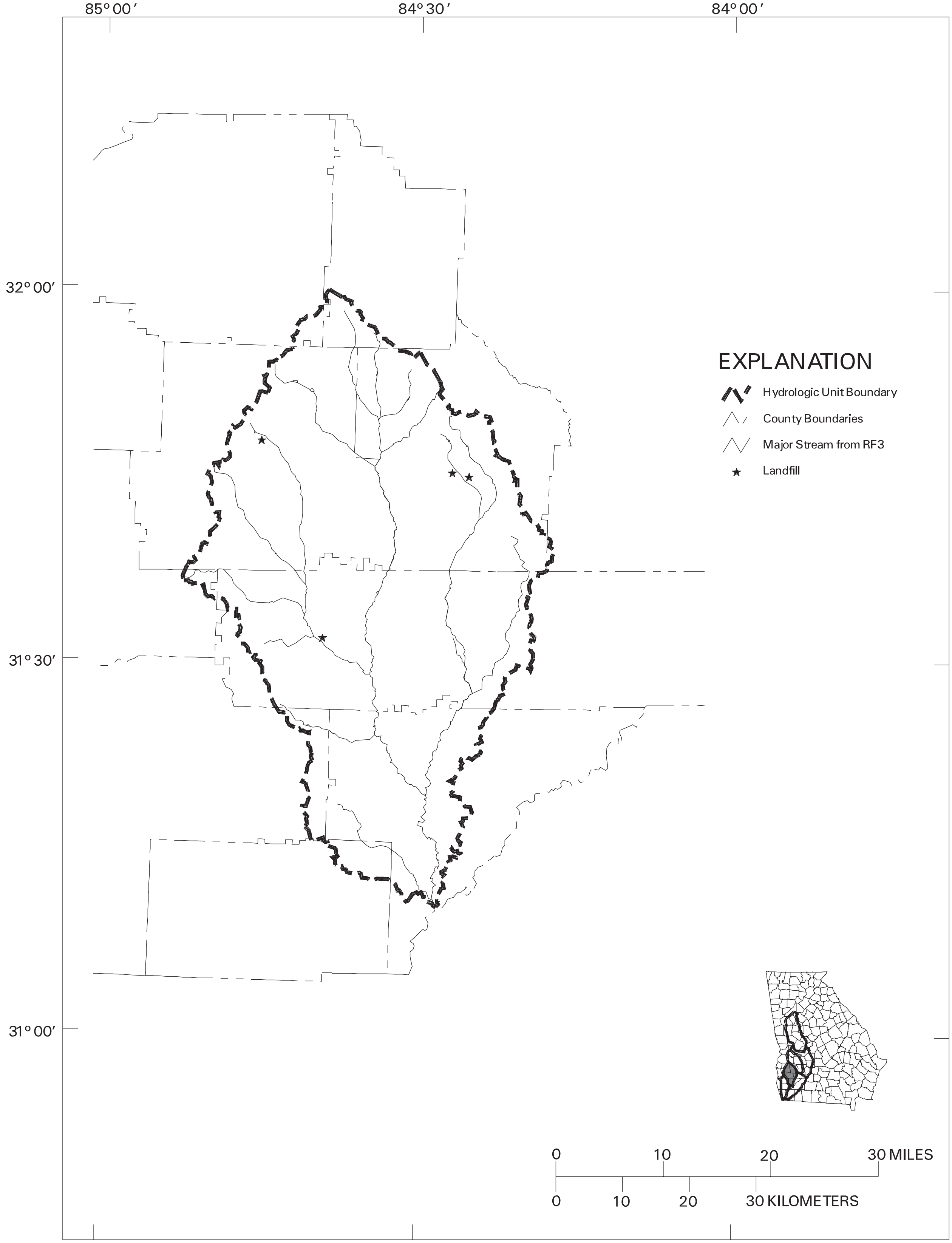

Figure 4-18. Landfills, Ichawaynochaway Creek Basin, HUC 03130009

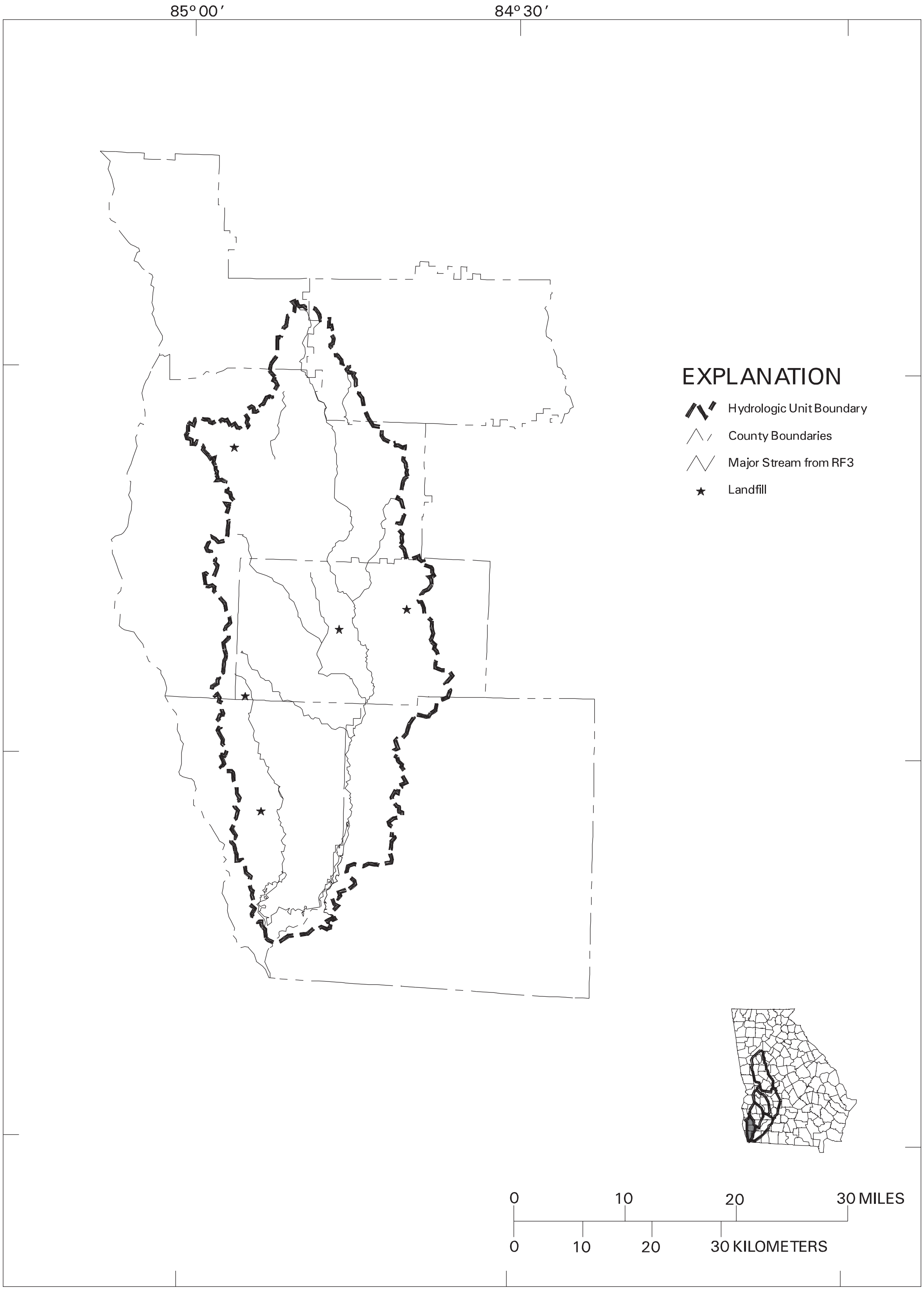

Figure 4-19. Landfills, Spring Creek Basin, HUC 03130010

Sediment and Nutrients

Sediment is the most common pollutant resulting from agricultural operations. It consists mainly of mineral fragments resulting from the erosion of soils, but may also include crop debris and animal wastes. Excess sediment loads can damage aquatic habitat by smothering and shading food organisms, altering natural substrate, and destroying fish spawning areas. Runoff with elevated sediment concentrations can also scour aquatic habitat causing significant impacts to the biological community. Excess sediment may also increase water treatment costs, interfere with recreational uses of water bodies, create navigation problems, and increase flooding damage. Second, a high percentage of nutrients lost from agricultural lands, particularly phosphorus, is transported sorbed to sediment. Many organic chemicals used as pesticides or herbicides are also transported predominantly sorbed to sediment.

Agriculture can also be a significant source of nutrients, which can lead to excess or nuisance growth of aquatic plants and depletion of dissolved oxygen in surface waters, or may cause contamination of ground water. The nutrients of most concern from agricultural land uses are nitrogen (N) and phosphorus (P), which may derive from commercial fertilizer or land application of animal wastes. Both nutrients assume a variety of chemical forms, including soluble ionic forms (nitrate and phosphate) and less soluble organic forms. Less soluble forms tend to travel with sediment, while more soluble forms move with water. Nitrate-nitrogen is very weakly adsorbed by soil and sediment, and is therefore transported entirely in water. Because of its mobility, the major route of nitrate loss is to streams by interflow or to groundwater in deep seepage.

Phosphorus transport is a complex process involving different components of phosphorus. Soil and sediment contain a pool of adsorbed phosphorus which tends to be in equilibrium with the phosphorus in solution (phosphate) as water flows over the soil surface. The concentrations established in solution are determined by soil properties and fertility status. Adsorbed phosphorus attached to soil particles suspended in runoff also equilibrates with the phosphorus in solution.

In 1993, the Soil Conservation Service (SCS, now NRCS) completed a study to identify hydrologic units in Georgia with high potential for nonpoint source (NPS) pollution problems resulting from agricultural land uses (SCS, 1993). This study concluded that there is not a major statewide agricultural pollution problem in Georgia. However, the assessment shows that some watersheds have sufficient agricultural loadings to potentially impair their designated uses, based on estimates of transported sediments, nutrients, and animal waste from agricultural lands.

In the SCS study, estimates of potential agricultural NPS loads were based on county units. An erosion index was developed for each county that included soil erodibility, slope, and slope length. Each county was assigned to one of seven Major Land Resource Areas on which a joint Agricultural Research Service (ARS) and EPA study (USDA Utilization Research Report No. 6 and EPA-600/2-79-059) gave estimates of annual runoff, pounds per acre of dissolved nitrogen and phosphorus from applied animal waste, and a method of converting pound per acre to parts per million (ppm) concentration in runoff from agricultural lands.

Data on agricultural lands, land use, and animal units were developed for each county and reviewed and modified by the local agricultural Field Advisory Committee. Erosion and sediment yield data bases were calculated and compiled for agricultural lands based on county erosion indexes and cover factors. Nutrient needs were also developed by county and watershed. Potential nutrient loads were based on a worst case scenario where nutrients needed for agricultural lands are provided entirely from commercial fertilizer and animal waste is not managed for its nutrient value. Erosion and sediment yields were developed based on county cropland and grassland data. Estimates include sheet, rill, and ephemeral gully erosion, factored by a delivery ratio to the streams.

Estimates of sediment, nitrogen and phosphorus loads from agricultural lands were calculated by SCS (1993) on a county basis, then converted to average concentrations per event. Reporting on a concentration basis helps account for the fact that county boundaries generally do not coincide with watershed boundaries. Estimates for agricultural loading for those counties with significant land area within the Flint River Basin are summarized in Table 4-7.

Based on these analyses, SCS (1993) and the Georgia Soil and Water Conservation Commission (GSWCC) also identified specific watersheds within the Flint River Basin which have potential water quality problems associated with agricultural runoff. The identification was updated by the GSWCC for inclusion in Georgia's 1995 305(b) report and is shown in Table 4-8. The list represented the best effort by the Federal and State agricultural agencies to identify potential water problem areas, but was not based on documented water quality problems. Mileages presented are based on taking a flat percentage of stream miles within the hydrologic unit and represent an estimate only.

In July and August of 1996, EPD conducted additional biological assessment of the waters listed in Table 4-8 to determine which of these waters should be added to Georgia's Section 303(d) list of water quality limited segments. Those waters designated with a “3" under 303(d) Priority Ranking were added to the § 303(d) list in December 1996. Those designated with a “0" were determined not to be water quality limited segments based on the July-August 1996 sampling.

Animal waste

Besides contributing to nutrient loads, animal waste may contribute high loads of oxygen demanding chemicals and bacterial and microbial pathogens. The waste may reach surface waters through direct runoff as solids or in their soluble form. Soluble forms may reach groundwater through runoff, seepage, or percolation and surface water as return flow. The organic materials place an oxygen demand on the receiving waters during their decomposition adversely impacting fisheries; and cause other problems with taste, odor, and color. The possible presence of pathogens including fecal bacteria that impact human health is of particular concern when waters are contaminated by waste from mammals.. In addition to bacteria, cattle waste may be an important source of the infectious oocysts of the protozoan parasite *Cryptosporidium parvum*.

Pesticides

Pesticides applied in agricultural production may be insoluble or soluble and include herbicides, insecticides, miticides and fungicides. Their primary transport mode is direct surface runoff, either in dissolved form or attached to sediment particles. Some pesticides may cause acute and chronic toxicity problems in the water or throughout the entire food chain. Others are suspected human carcinogens, although the use of these pesticides has generally been discouraged in recent years.

Table 4-7. Estimated Loads from Agricultural Lands by County (SCS, 1993)

County	Acres with nutrient application	Sediment (tons)	Sediment (ppm)	Nitrogen (tons)	Nitrogen (ppm)	Phosphorus (tons)	Phosphorus (ppm)
Hydrologic Unit 03130005, Upper Flint River Basin							
Clayton	6,279	2,580	14.5	9	0.05	4	0.020
Coweta	39,214	39,641	34.3	114	0.10	45	0.040
Crawford	32,246	14,480	33.8	57	0.15	20	0.053
Lamar	43,907	32,016	24.7	116	0.09	42	0.034
Meriwether	60,489	45,424	25.1	133	0.08	53	0.031
Pike	35,616	38,090	31.1	131	0.13	50	0.049
Spalding	19,818	24,366	42.0	74	0.13	28	0.050
Talbot	28,085	13,551	16.6	42	0.05	17	0.021
Taylor	62,645	39,649	45.5	116	0.16	43	0.059
Upson	37,718	12,767	11.4	75	0.07	27	0.025
Hydrologic Unit 03130006, Middle Flint River Basin							
Crisp	0	144,216	56.0	374	0.16	148	0.061
Dooly	112,931	154,242	47.4	420	0.15	158	0.058
Macon	93,230	88,717	65.2	200	0.09	44	0.020
Schley	22,072	29,172	39.6	83	0.16	31	0.059
Worth	140,433	147,585	39.2	413	0.12	156	0.046
Hydrologic Unit 03130007, Kinchafoonee-Muckalee Creek Basin							
Lee	72,356	59,749	25.1	202	0.12	67	0.039
Marion	25,465	12,902	10.6	256	0.85	99	0.330
Sumter	131,559	159,067	40.6	447	0.14	168	0.053
Webster	30,055	33,070	34.5	88	0.12	34	0.047
Hydrologic Unit 03130008, Lower Flint River Basin							
Decatur	111,836	118,568	30.2	334	0.11	128	0.040
Dougherty	51,248	29,843	19.8	90	0.07	34	0.027
Mitchell	149,965	148,860	32.8	441	0.12	162	0.045
Hydrologic Unit 03130009, Ichawaynochaway Creek Basin							
Baker	77,762	44,280	21.7	130	0.07	49	0.026
Calhoun	0	83,365	44.2	225	0.13	88	0.052
Randolph	67,758	120,441	60.3	317	0.19	124	0.075
Terrell	71,265	84,052	28.8	216	0.13	85	0.049
Hydrologic Unit 03130010, Spring Creek Basin							
Early	123,292	146,088	32.6	391	0.13	153	0.051
Miller	94,148	58,928	22.0	180	0.08	66	0.029
Seminole	74,143	51,918	24.1	148	0.08	56	0.031

Note: Mass estimates are based on whole county. Concentration estimates are average event runoff concentration from agricultural lands.

Table 4-8. List of Watersheds Potentially Impacted by Agricultural Nonpoint Source Pollution in the Flint River Basin

HUC	Watershed Name - County	River Miles	§ 303(d) Priority
3130005	Patsiliga Creek - Taylor	16	0
3130005	Potato Creek - Lamar and Upson	26	0
3130005	Red Oak Creek - Meriwether	19	3
3130005	White Water Creek - Macon and Taylor	21	3
3130006	Camp and Lime Creek - Schley, Sumter and Macon	23	3[1]
3130006	Hogcrawl and Spring Creek - Dooly and Macon	26	3[2]
3130006	Chokee Creek - Sumter and Lee	8	0
3130006	Swift Creek - Crisp and Worth	15	0
3130007	Lower Kinchafoonee Creek - Terrell and Lee	11	3
3130007	Muckalee Creek - Schley and Sumter	35	0
3130008	Big Creek - Grady and Decatur	16	0
3130008	Cooleewahee Creek - Baker and Dougherty	5	3
3130008	River Bend-Baconton - Mitchell	2	3[3]
3130008	Big Slough - Grady and Mitchell	7	3[3]
3130009	Lower Pachitla Creek - Baker, Calhoun and Early	13	0
3130009	Chickasawhatchee Creek - Terrell	23	3
3130009	Pachitla Creek - Randolph and Calhoun	20	3
3130009	Ichawaynochaway Creek - Randolph and Terrell	24	0
3130009	Lower Chickasawhatchee Creek - Baker and Calhoun	12	0
3130010	Fishpond Drain - Seminole	2	3[3]
3130010	Spring Creek - Calhoun, Clay, Early and Miller	13	0
3130010	Aycocks Creek - Early and Miller	18	0

[1] Only Camp Creek in Schley County was placed on 303(d) list.

[2] Only Spring Creek in Macon County was placed on 303(d) list.

[3] These segments were dry during the July-August 1996 sampling, so EPD was unable to collect data to support the omission of these segments from the 303(d) list.

Use of agricultural pesticides / herbicides within the basin is described in Stell et al., (1995). For the Flint and Chattahoochee basins combined, data compiled from the Georgia Herbicide Use Survey Summary (Monks and Brown, 1991) indicate that bentazon, paraquat, 2,4-DB, methanearsonates (MSMA / DSMA), alachlor, and pendimethalin were used to treat the largest number of acres (from 307,000 to 205,000 acres); and alachlor, MSMA / DSMA, fluometuron, atrazine, metolachlor, and bentazon were applied in the greatest quantities (from 506,000 to 185,000 pounds of active ingredient. Since 1990, the use of alachlor in Georgia has decreased dramatically (about 98 percent) in response to market conditions, as peanut wholesalers will no longer buy peanuts treated with alachlor. Metolachlor, rather than alachlor, is now being applied to peanuts.

Non-herbicide pesticide use is difficult to estimate. According to Stell et al., pesticides other than herbicides are currently used only when necessary to control some type of infestation (nematodes, fungi, insects), and chlorothalonil, aldicarb, chlorpyrifos, methomyl, thiodicarb, carbaryl, acephate, fonofos, methyl parathion, terbufos, disulfoton, phorate, triphenyltin hydroxide (TPTH), and synthetic pyrethroids / pyrethrins are commonly used. Application periods of the principal agricultural pesticides span the calendar year in the basin; however, agricultural pesticides are applied most intensively and on a broader range of crop types from March 1 to September 30 in any given year.

It should be noted that past uses of persistent agricultural pesticides which are now banned may continue to impact water quality within the basin, particularly through residual concentrations present in bottom sediments. The survey of pesticide concentration data by Stell et al., found that nearly 56 percent of the analyses in water and sediment having concentrations at or above minimum reporting levels were for two groups: DDT and metabolites, and chlordane and related compounds (heptachlor, heptachlor epoxide), while dieldrin was also frequently detected. All these pesticides are now banned by USEPA for use in the United States, but may persist in the environment for long periods of time.

Prime Farmland Conversion

Between 1982 and 1992 four million acres of Georgia prime farmland were lost to urban and suburban development. Nonpoint source pollution delivery coefficients tend to be higher for urban/suburban land uses in comparison to prime farmland, which by definition is relatively flat with soils that are highly permeable.

4.1.2.2 Nonpoint Sources from Urban, Industrial, and Residential Lands

Water quality in urban waterbodies is the result of both point source discharges and the impact of diverse land activities in the drainage basin (i.e., nonpoint sources). One of the most important sources of environmental stressors in the Flint basin, and particularly in the developed and rapidly growing areas around Atlanta and Albany, is diffuse runoff from urban, industrial, and residential land uses (jointly referred to as “urban runoff”). Nonpoint source contamination can lead to impairment in streams draining extensive commercial and industrial areas, where stormwater runoff, unauthorized discharges, and accidental spills may contribute to pollutant loading. Wet weather urban runoff can carry high concentrations of many of the same pollutants found in point source discharges, such as oxygen demanding waste, suspended solids, synthetic organic chemicals, oil and grease, nutrients, lead and other metals, and bacteria. The major difference is that urban runoff only occurs intermittently, in response to precipitation events.

The characteristics of nonpoint urban runoff are generally similar to those of NPDES permitted stormwater discharges (Section 4.1.1.2). Separate stormwater systems, however, are typically found in developed areas with high imperviousness and, frequently, sanitary sewer systems. Nonpoint urban runoff includes drainage from some builtup areas with similar characteristics, but also includes less highly developed areas with greater amounts of pervious surfaces. Nonpoint urban runoff is likely to include a larger percentage of drainage from areas including lawns, gardens, and septic tanks, all of which may be sources of nutrient load.

At present, little site-specific data are available to quantify loading in nonpoint urban runoff in the Flint River Basin, although estimates of loading rates by land use types have been widely applied in other areas. Peters and Kandell (1997) present a water quality index for streams in the Atlanta region, based primarily on nutrients and nutrient-related parameters because data for metals, organics, biological conditions, and suspended sediment were generally unavailable. They report that the annual average index of water quality conditions generally improved at most long-term monitoring sites between 1986 and 1995. However, conditions markedly worsened between 1994 and 1995 at several sites where major development was ongoing.

Urban and suburban land uses are also a potential source of pesticides and herbicides through application to lawns and turf, roadsides, and gardens and beds. Stell et al., (1995) provide a summary of usage in the Atlanta Metropolitan Statistical Area (MSA). The herbicides most commonly used by the lawn-care industry are combinations of dicamba, 2,4-D, mecoprop (MCPP), 2,4-DP, and MCPA, or other phenoxy-acid herbicides, while most commercially available weed control products contain one or more of the following compounds: glyphosphate, methyl sulfometuron, benefin (benfluralin), bensulide, acifluorfen, 2,4-D, 2,4-DP, or dicamba. Atrazine was also available for purchase until it was restricted by the State of Georgia on January 1, 1993. The main herbicides used by local and State governments are glyphosphate, methyl sulfometuron, MSMA, 2,4-D, 2,4-DP, dicamba, and chlorsulforon. Herbicides are used for preemergent control of crabgrass in February and October, and in the summer for postemergent control. Data from the 1991 Georgia Pest Control Handbook (Delaplane, 1991) and a survey of CES and SCS personnel conducted by Stell et al., indicate that several insecticides could be considered ubiquitous in urban/suburban use, including chlorpyrifos, diazinon, malathion, acephate, carbaryl, lindane, and dimethoate. Chlorothalonil, a fungicide, is also widely used in urban and suburban areas.

Stell et al., estimated that there are about 190 mi^2 of lawns in the Atlanta MSA part of the Chattahoochee and Flint basins, of which home owners apply pesticides to about 120 mi^2 and the lawn care industry applies pesticides to about 23 mi^2, with the remainder of lawns untreated. Other types of urban/suburban land receiving pesticide treatment include golf courses, roadsides, local government land, parks, industrial land, and schools.

Urban and residential stormwater also potentially includes pollutant loads from a number of other terrestrial sources:

Septic Systems. Poorly sited and improperly operating septic systems can contribute to the discharge of pathogens and oxygen-demanding pollutants to receiving streams. This problem is addressed through septic system inspections by the appropriate County Health Department, extension of sanitary sewer service and local regulations governing minimum lot sizes and required pump-out schedules for septic systems.

Leaking Underground Storage Tanks. The identification and remediation of leaking underground storage tanks is the responsibility of the EPD Land Protection Branch. Petroleum hydrocarbons and lead are typically the pollutants associated with LUSTs.

4.1.2.3 Nonpoint Sources from Forestry

Undisturbed forest land is generally associated with low rates of stressor loading compared to other land uses, and conversion of forest to urban/residential land uses is often associated with water quality degradation. Silvicultural operations can also serve as sources of stressors, particularly excess sediment loads to streams, when proper management practices are not followed. Potential effects of silvicultural management activities on aquatic ecosystems are primarily alterations in physical habitat, such as increased temperature due to the loss of shade from riparian vegetation, and increased sedimentation.

Many existing woods roads are being used and new roads are being built to access timber. From a water quality standpoint, roads pose the greatest potential threat of any of the typical forest practices. It has been documented that 90 percent of the sediment that entered streams from a forestry operation was directly related to either poorly located or poorly constructed roads. Estimates in Georgia are that there are approximately 3,000 annual harvesting operations conducted in the state so the potential impact to water quality from erosion and sedimentation is great if Best Management Practices (BMPs) are not adhered to.

Silviculture is also a potential source of pesticides / herbicides. According to Stell et al., pesticides are mainly applied during site preparation after clear-cutting and during the first few years of new forest growth. Site preparation occurs on a 25-year cycle on most pine plantation land, so the area of commercial forest with pesticide application in a given year is relatively small. The herbicides glyphosphate (Accord), sulfometuron methyl (Oust), hexazinone (Velpar), imazapyr (Arsenal) and metsulfuron methyl (Escort) account for 95 percent of the herbicides used for site preparation to control grasses, weeds, and broadleaves in pine stands. Dicambia, 2,4-D, 2,3-DP (Banvel), Triclopyr (Garlon) and picloram (Tordon) are minor use chemicals used to control hard to kill hardwoods and kudzu. The use of triclopyr and picloram has decreased since the early 1970s.

Most herbicides are not mobile in the soil and are targeted to plants not animals. Applications made following the label and in conjunction with BMPs should pose little threat to water quality.

Control of insects and diseases is not widely practiced except in forest tree nurseries which is a very minor land use. Insects in pine stands are controlled by chlorpyrifos, diazinon, malathion, acephate, carbaryl, lindane, and dimethoate. Diseases are controlled using chlorothalonil, dichloropropene, and mancozeb.

4.1.2.4 Atmospheric Deposition

Atmospheric deposition can be a significant source of nitrogen and acidity in watersheds. Nutrients from atmospheric deposition, primarily nitrogen, are distributed throughout the entire basin in precipitation. The primary source of nitrogen in atmospheric deposition is nitrogen oxide emissions from combustion of fossil fuels. The rate of atmospheric deposition is a function of topography, nutrient sources, and spatial and temporal variations in climatic conditions.

Frick et al., (1996) report estimates of nitrogen loading from atmospheric deposition to the Flint River Basin as of 1990. Over the whole Flint basin they estimated an annual input of approximately 10,000 tons of nitrogen via atmospheric deposition, distributed as follows:

Hydrologic unit code	Subbasin Name	Atmospheric Deposition (tons of N per year)
03130005	Upper Flint	3,100
03130006	Middle Flint	1,800
03130007	Kinchafoonee-Muckalee	1,300
03130008	Lower Flint	1,500
03130009	Ichawaynochaway	1,300
03130010	Spring	910

Data are not available nationally to estimate phosphorus input from atmospheric deposition; however, this component is expected to be of minor significance (Frick et al., 1996).

Atmospheric deposition may also be a source of certain mobile toxic pollutants. In particular, mercury found in fish in the upper Flint basin is thought to derive in part from atmospheric deposition. Atmospheric deposition also contributes small background loads of PCBs and other organic chemicals.

4.1.3 Flow And Temperature Modification

Aquatic ecosystems of the Flint River Basin are also influenced by hydrologic alterations resulting from hydropower operations and the maintenance of navigation channels. In contrast to the Chattahoochee River, which is highly regulated by the operation of 13 dams, the Flint River posesses only two dams. Both the Warwick and Flint River Dams, which are run-of-the-river and contain very little storage capacity, are located on the lower Flint River. The upper Flint River is one of only 42 unregulated river reaches of at least 125 mi. in length remaining in the contiguous United States.

Because there are very large seasonal withdrawals of groundwater (2000 MGD or more) for irrigation in the lower Flint River Basin, and because the Flint is very dependent on groundwater recharge, especially during the dry season, agricultural withdrawals can have a significant effect on the river flow rates. The USGS has studied the relationship of groundwater pumping and streamflow recharge in the area of the Flint basin and has determined that, under long term steady state conditions of large withdrawals during a drought, there may be a cumulative reduction of up to 30% in river recharge rates. Such a reduction could have a significant effect on flows and temperatures in the Flint during late summer.

4.1.4 Physical Habitat Alteration

Many forms of aquatic life are sensitive to physical habitat disturbances. Probably the major disturbing factor is erosion and loading of excess sediment, which changes the nature of the stream substrate. Thus, any land use practices that cause excess sediment input can have significant effects.

Physical habitat disturbance is evident in many urban streams. Increased impervious cover in urban areas can result in high flow peaks, which increase bank erosion. In addition, construction and other land disturbing activities in these areas often provides an excess sediment load, resulting of choking of the natural substrate and physical form of streams with banks of sand and silt.

Another important form of physical habitat disruption is loss of riparian tree cover. Under natural conditions, smaller streams in Georgia are shaded by a tree canopy. If this canopy is removed the resulting direct sunlight can result in increased water temperatures with adverse effects on native aquatic life. Habitat disturbance through construction of small impoundments can also raise water temperatures.

4.2 Stressor Summary

Section 4.1 described the major sources of loads of pollutants (and other types of stressors) to the Flint basin. What happens in the river, however, is often the result of the combined impact of many different types of loading, including point and nonpoint sources. For instance, excess loads of nutrients may represent the net effect of wastewater treatment plant discharges, runoff from agriculture, runoff from residential lots, and other sources. Accordingly, Section 4.2 brings together the information contained in Section 4.1 to focus on individual stressor types, as derived from all sources.

4.2.1 Nutrients

All plants require certain nutrients for growth, including the algae and rooted plants found in lakes, rivers, and streams. Nutrients required in the greatest amounts include nitrogen and phosphorus. Some loading of these nutrients is needed to support normal growth of aquatic plants, an important part of the food chain. Too much loading of nutrients can, however, result in an over-abundance of algal growth with a variety of undesirable impacts. The condition of excessive nutrient-induced plant production is known as eutrophication, and waters affected by this condition are said to be eutrophic. Eutrophic waters often experience dense blooms of algae, which can lead to unaesthetic scums and odors and interfere with recreation. In addition, overnight respiration of living algae, and decay of dead algae and other plant material, can deplete oxygen from the water, stressing or killing fish. Eutrophication of lakes typically results in a shift in fish populations to less desirable, pollution tolerant species. Finally, eutrophication may result in blooms of certain species of blue-green algae which have the capability of producing toxins.

For freshwater aquatic systems, the nutrient which is in the shortest supply relative to plant demands is usually phosphorus. Phosphorus is then said to be the limiting nutrient, because the concentration of phosphorus limits potential plant growth. Control of nutrient loading to reduce eutrophication thus focuses on phosphorus control.

Point and nonpoint sources to the Flint also discharge large quantities of nitrogen, but nitrogen is usually present in excess of amounts required to match the available phosphorus. Nitrogen (unlike phosphorus) is also readily available in the atmosphere and ground water, so it is not usually the target of management to control eutrophication in fresh water. The bulk of the nitrogen in fresh water systems is found in one of three ionic forms: ammonium (NH_4^+), nitrite (NO_2^-), and nitrate (NO_3^-). Nitrite and nitrate are more readily taken up by most algae, but ammonia is of particular concern because it can be toxic to fish and other aquatic life. Accordingly, wastewater treatment plant upgrades have focused on reducing the toxic ammonia component of discharges, with corresponding increase in the nitrate fraction.

The major sources of nutrient loading in the Flint basin are agricultural runoff, urban runoff and stormwater, and wastewater treatment facilities. Concentrations found within rivers and lakes of the Flint basin represent a combination of a variety of point and nonpoint source contributions.

Point source loads can be quantified from permit and effluent monitoring data, but nonpoint loads are difficult to quantify. Rough estimates of average nutrient loading rates from agriculture are available (Section 4.1.2.1); however, nonpoint loads from urban / residential sources in the basin have not yet been quantified. The net load arising from all sources may, however, be examined from instream monitoring. Long term trends in nutrients within the Flint River Basin for 1972–90 are summarized by Frick et al., (1996). An even more informative picture is obtained by examining results from EPD long-term trend monitoring stations from 1968 to present.

Trends in loading of total phosphorus can be seen by examining results at four stations: Flint River at Ackert Road near Inman (just south of Atlanta), Flint River at Georgia Highways 26 and 49 near Oglethorpe (between Atlanta and Lake Blackshear), Flint River at the Plant Mitchell intake (just south of Albany), and Flint River at the State Docks (at the Flint River inflow to Lake Seminole).

In the 1970s, loading of phosphorus to the upper Flint River just south of Atlanta was mainly due to discharge from three secondary wastewater treatment plants, along with several package plants and oxidation ponds. Figure 4-20 shows individual trend-monitoring measurements since 1971 as points. Superimposed on these points is a moving-average line, representing long-term trends. The median (50^{th} percentile) phosphorus concentration observed at this station is 0.27, and the maximum observed was 1.58 mg/l (in 1980). As of 1979, two of the treatment plants (located in Clayton County) were upgraded to provide pretreatment for a land application system, which continues to be in operation. In 1984, the City of Atlanta completed construction of pump and pipeline that diverted wastewater from the third treatment plant (the Atlanta Flint River Plant [6 MGD]) to the Chattahoochee River, due to its higher waste assimilation capacity. The result of these changes can be observed as a sharp decline in total phosphorus concentrations between 1981 and 1984. However, during the 80's, expanding urbanization resulted in increasing phosphorus concentrations in the upper Flint. In 1990, State legislation was passed limiting the amount of phosphorus in various household and commercial detergents. Since this time, instream phosphorus concentrations have been steadily dropping in the upper Flint River. In 1995, the median phosphorus concentration at the Ackert Road station was 0.07 mg/l.

Table 4-9 summarizes the statistics for the four stations discussed in this section. The last column of this table displays the percent of observations that exceeded 0.1 mg/l; this column is useful for comparative purposes, and does not indicate violations of a water quality standard. The three stations below Inman (Figures 4-21 through 4-23) have similar median concentrations, though the station near Albany has a slightly higher median than the other two, indicating the influence of wastewater treatment plant discharges from the City of Albany. The fact that concentrations of phosphorus above Albany and at the inflow to Lake Seminole (far below Albany) remain somewhat elevated despite the lack of significant point sources may be an indication of the influence of nonpoint loading of phosphorus, mainly from the many agricultural operations in the middle and lower Flint basin.

All three trend monitoring stations below Inman showed a simultaneous increase in phosphorus concentrations beginning in 1988, and dropping off again from 1990 to 1992. This may be related to record low flows in the Flint River in 1988 and 1990 (see Figure 2-10), resulting in less dilution of phosphorus loads. Between 1972 and 1990, the stations at Albany and Lake Seminole showed no significant change in total phosphorus concentrations, while the Oglethorpe station showed a statistically significant increase (Frick et al., 1996). As there is no significant wastewater discharge in the vicinity of Oglethorpe, this increase must be attributable to increases in nonpoint loading, probably from agricultural operations in the area.

4.2.2 Oxygen Depletion

Oxygen is required to support aquatic life, and Georgia quality standards specify minimum and daily average dissolved oxygen concentration standards for all waters. Problems with oxygen depletion in the rivers and streams of the Flint basin are, for the most part, associated with

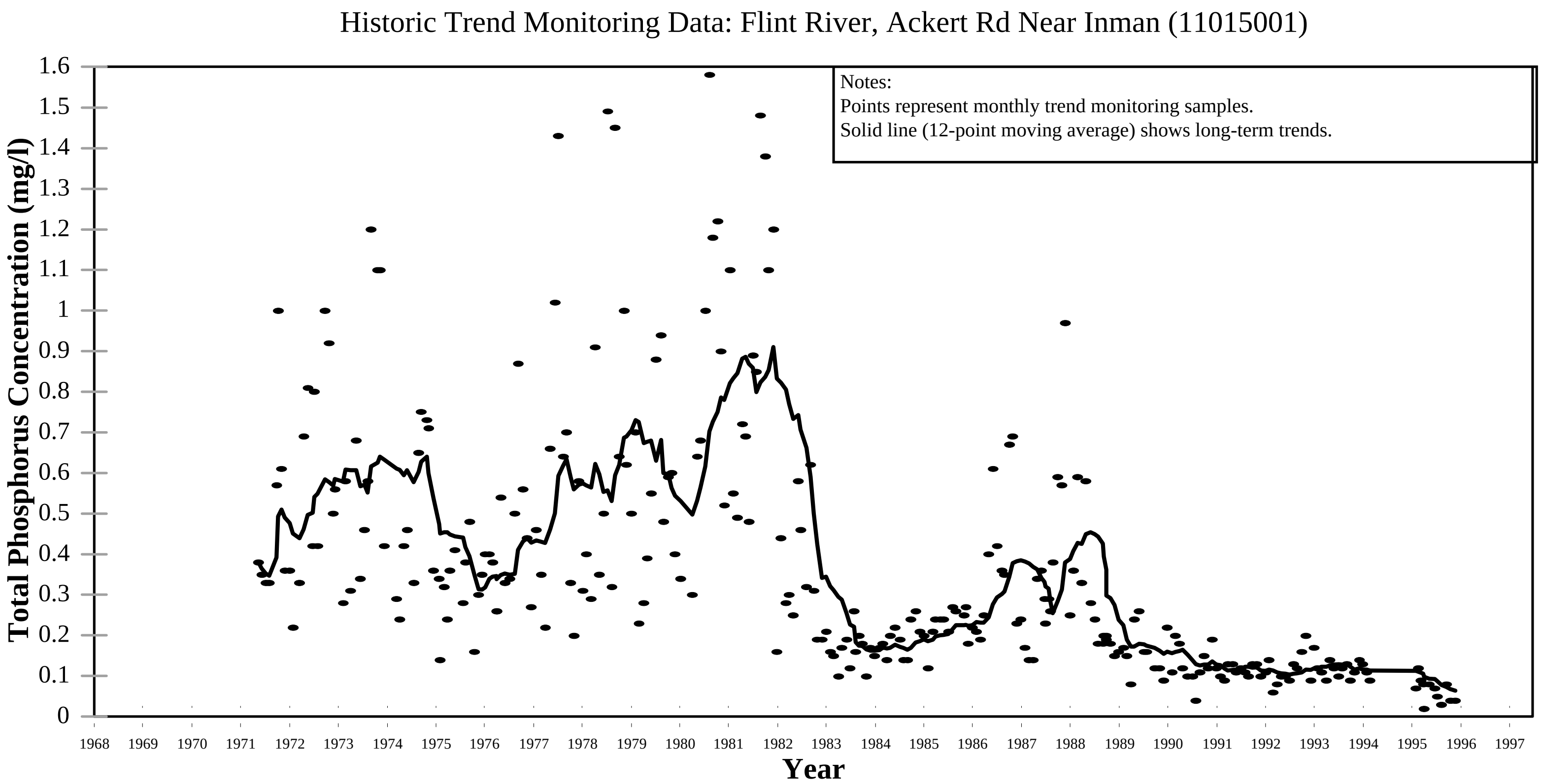

Figure 4-20. Total Phosphorus Concentrations, Flint River Near Inman, 1968-1997

Table 4-9. Summary of Phosphorus Concentration Data in Flint River Mainstem, 1968-1997

Station	Phosphorus Concentrations (mg/l)			Percent Above 0.1
	Max (Year)	Median	1995-96 Median	
Ackert Road near Inman	1.58 (1980)	0.27	0.07	89.1
Georgia Highways 26 and 49 near Oglethorpe	0.47 (1977)	0.06	0.03	15.1
Plant Mitchell Intake south of Albany	0.54 (1989)	0.08	0.05	26.5
State Docks at Lake Seminole Inflow	0.31 (1989)	0.06	0.03	15.4

oxygen demanding wastes from point and nonpoint sources. Historically, the greatest threat to maintaining adequate oxygen levels to support aquatic life has come from the discharge of oxygen-demanding wastes from wastewater treatment plants. Treatment upgrades and more stringent permit limits have reduced this threat substantially.

In the 1994-95 Georgia water quality assessment (EPD, 1996), several portions of the Flint River and its tributaries were not supporting designated uses due to violations of dissolved oxygen. The majority of the problems lie in the metropolitan areas of the basin where there is more influence from urban runoff.

Dissolved oxygen data from the four EPD trend monitoring stations used in section 4.2.1 are summarized in Figures 4-24 through 4-27, and in Table 4-10. The last column of this table displays the percent of observations that fell below 5.0 mg/l; this column is useful for comparative purposes, and does not indicate the number of violations of water quality standards (which have changed over the period of record of this station). The Inman station (Figure 4-24) has shown a marked improvement in dissolved oxygen as a result of wastewater treatment plant upgrades and diversions (as discussed in 4.2.1). While 13.6% of observations fell below the standard, no such violations have been recorded since 1987. Near Oglethorpe, average dissolved oxygen levels have remained approximately unchanged since 1968. This area has never been strongly impacted by wastewater treatment plants or by urban nonpoint source pollution, which are the typical sources of oxygen-demanding waste. As a result, there are no recorded violations of the standard at the Oglethorpe station. The Plant Mitchell station is influenced by treated wastewater discharge in Albany, but the median oxygen level is not much lower than at Oglethorpe (7.9 mg/l vs. 8.4 mg/l) and oxygen levels have not often dipped below the standard; the last violation was in 1981. There appears to be a moderate improvement in dissolved oxygen levels over the course of this record. The Lake Seminole station also has shown very few violations of the dissolved oxygen standard (none since 1975).

4.2.3 Metals

All of these stations show the seasonal dependence of dissolved oxygen levels (dashed line in the figures), which are typically lower during the summer months.

Violations of water quality standards for metals (i.e., lead, copper, and zinc) were the second most commonly listed causes of non-support of designated uses in the Flint River Basin in the 1994-95 water quality assessment (23 segments). In most cases, these metals are attributed to nonpoint source urban runoff. Point sources of metals in the Flint basin have generally been

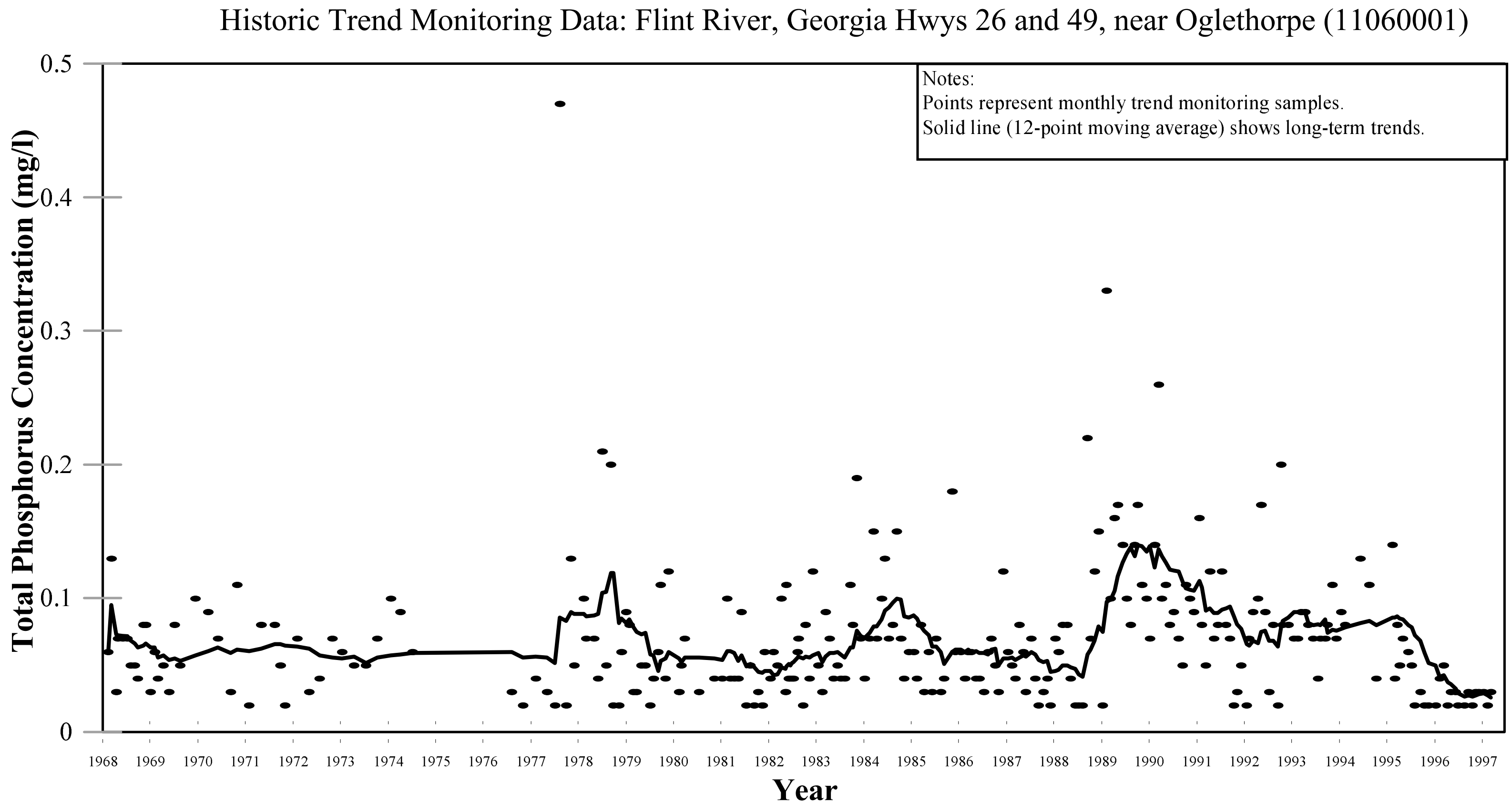

Figure 4-21. Total Phosphorus Concentrations, Flint River Near Oglethorpe, 1968-1997

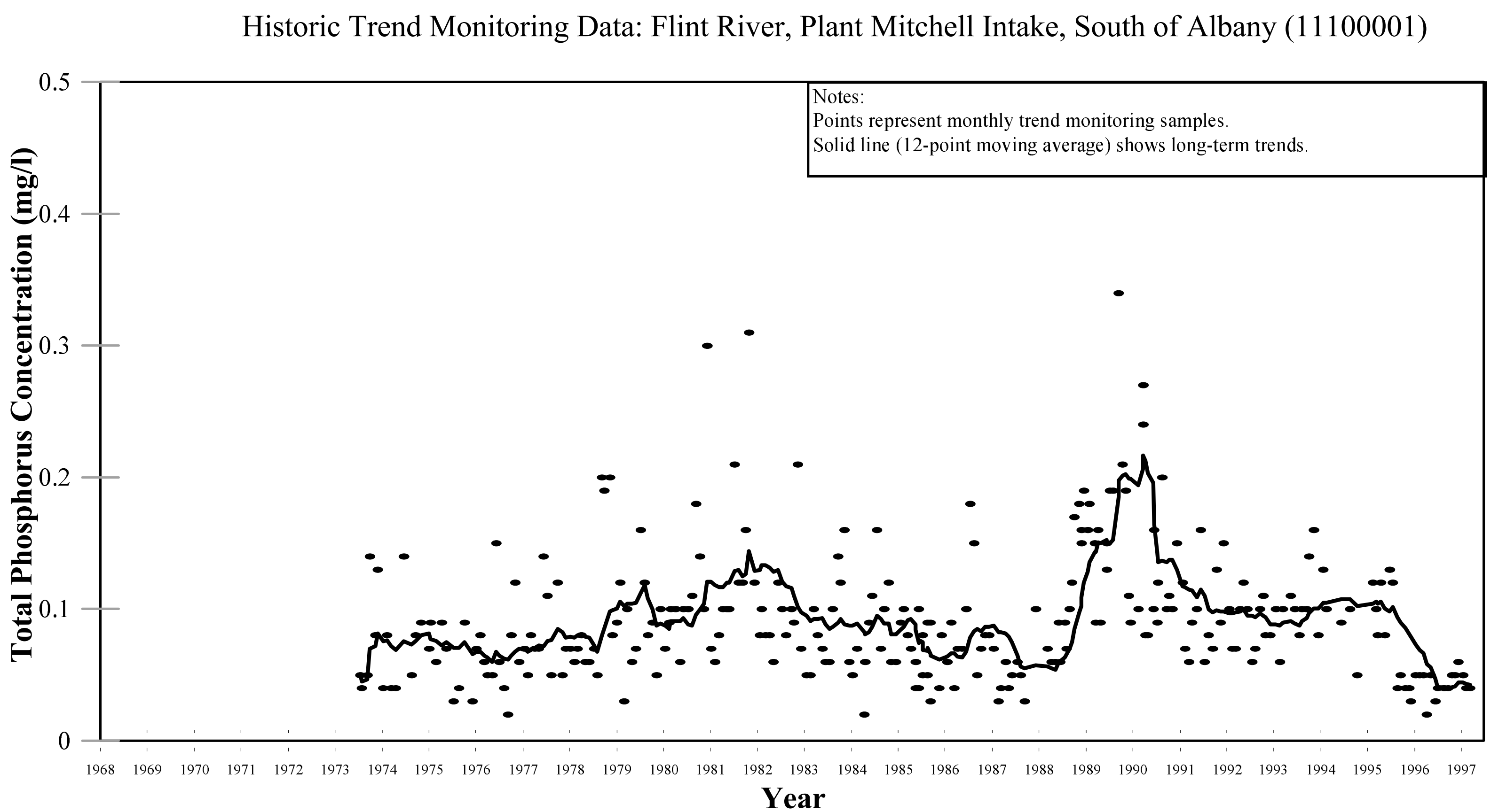

Figure 4-22. Total Phosphorus Concentrations, Flint River, South of Albany, 1968-1997

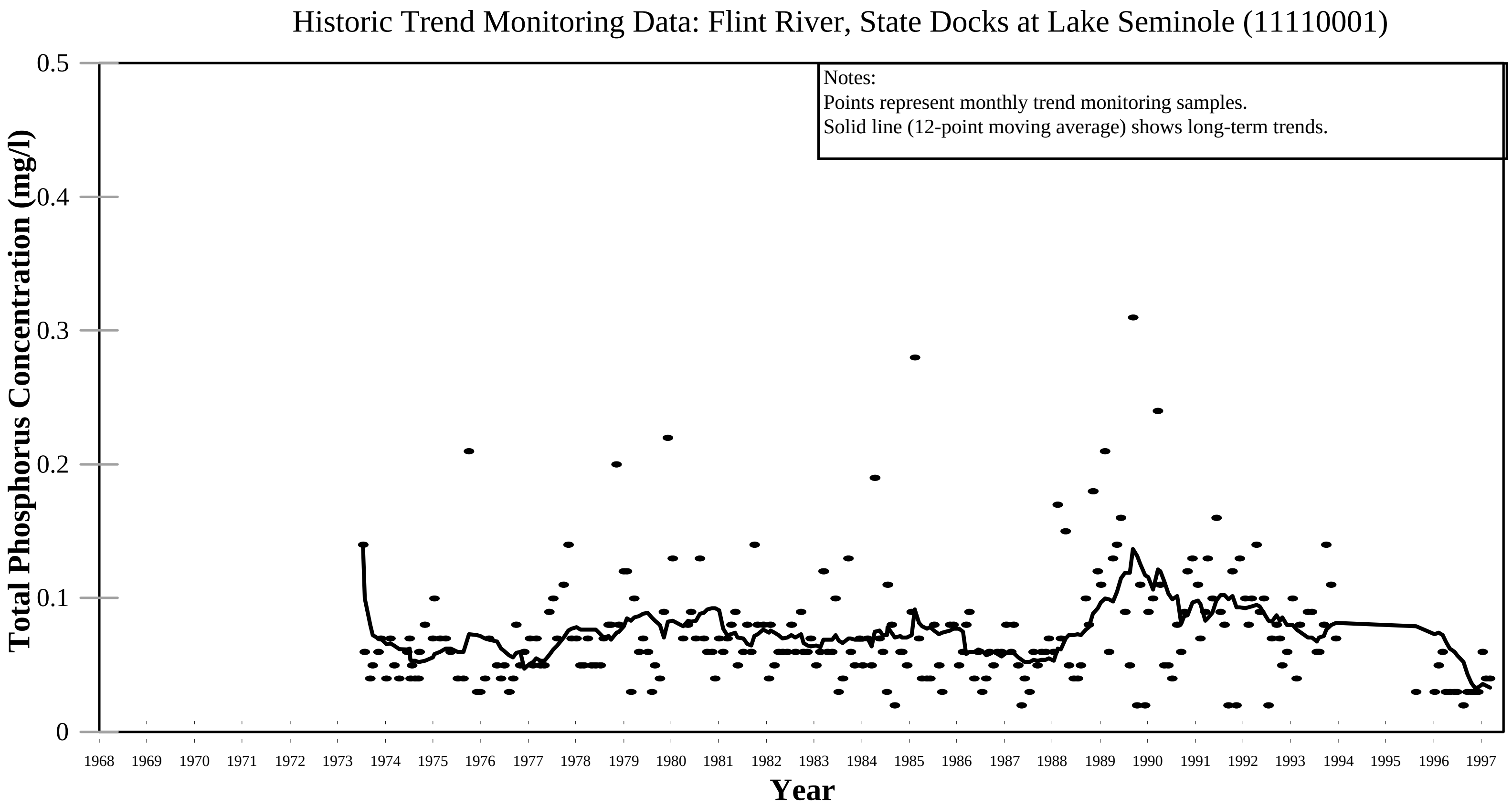

Figure 4-23. Total Phosphorus Concentrations, Flint River, State Docks at Lake Seminole, 1968-1997

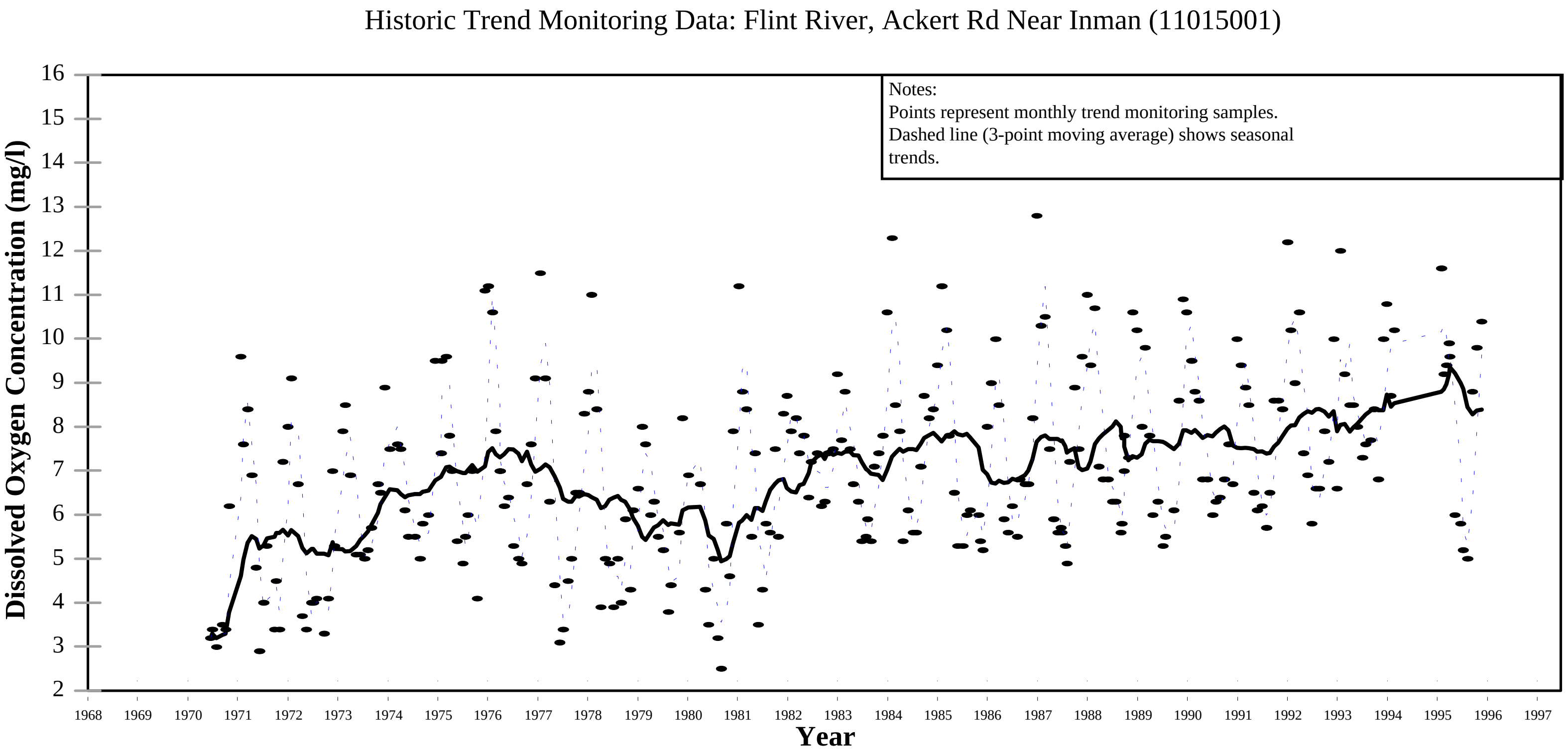

Figure 4-24. Dissolved Oxygen Concentrations, Flint River Near Inman, 1968-1997

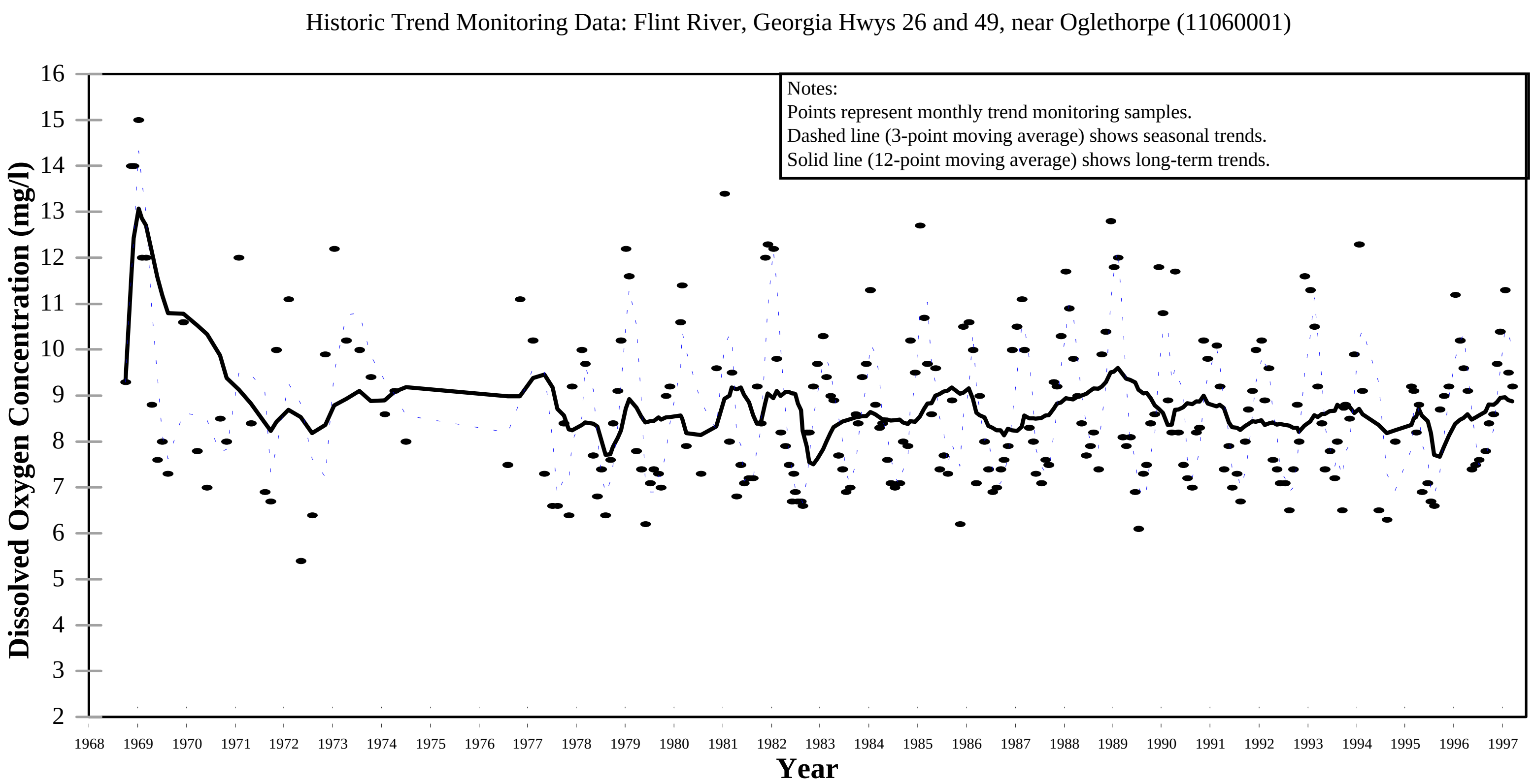

Figure 4-25. Dissolved Oxygen Concentrations, Flint River, Near Oglethorpe, 1968-1997

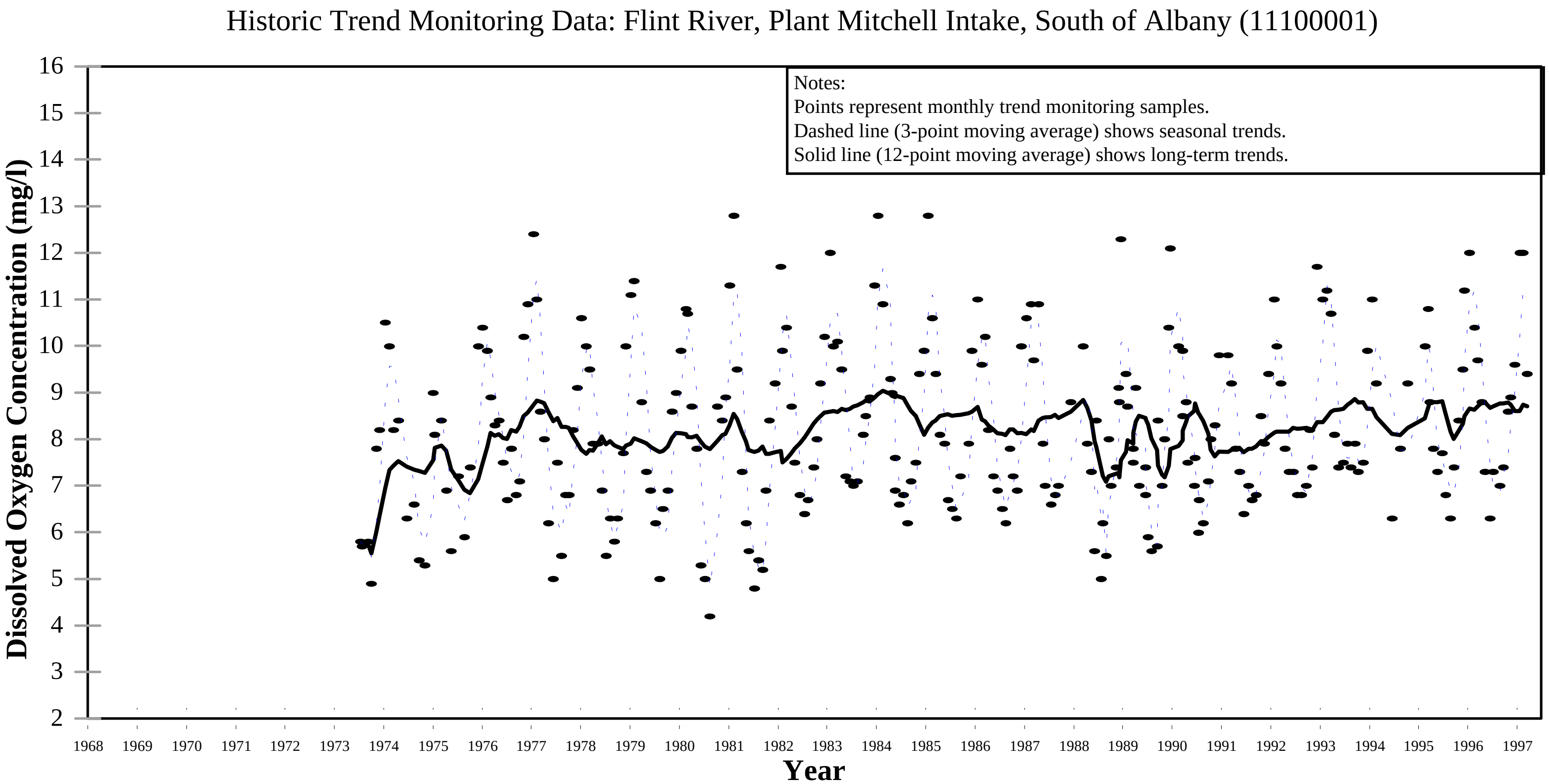

Figure 4-26. Dissolved Oxygen Concentrations, Flint River, South of Albany, 1968-1997

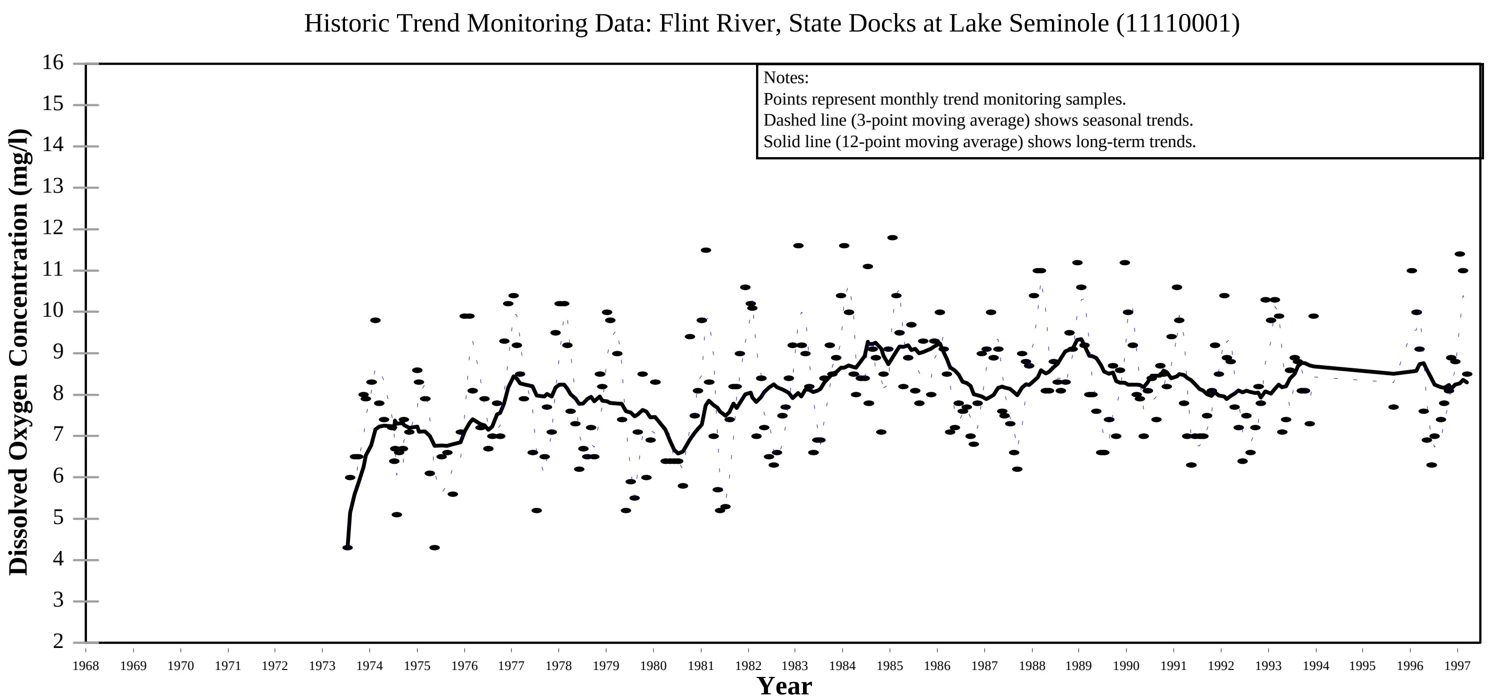

Figure 4-27. Dissolved Oxygen Concentrations, Flint River, State Docks at Lake Seminole, 1968-1997 `

Table 4-10. Summary of Dissolved Oxygen Concentration Data in Flint River Mainstem, 1968-1997

Station	Dissolved Oxygen Concentrations (mg/l)			Percent Below 5.0
	Min (Year)	Median	1995-96 Median	
Ackert Road near Inman	2.5 (1980)	6.8	9.3	13.6
Georgia Highways 26 and 49 near Oglethorpe	5.4 (1972)	8.4	8.7	0
Plant Mitchell Intake south of Albany	4.2 (1980)	7.9	8.5	1.1
State Docks at Lake Seminole Inflow	4.3 (1975)	8.1	7.8	0.8

brought into compliance through permits, leaving the more difficult nonpoint sources as the primary cause of impairment.

Data and analysis on metals in many streams of the Flint basin is rather sparse. There is also some concern as to the accuracy of the older data. While urban runoff appears to be the primary source of metal loading throughout Georgia, loading rates have not been quantified and will require additional analysis.

Within the Coastal Plain Province of the Flint River Basin, mercury is a metal of concern. Mercury is a naturally occurring metal that recycles between land, water, and air. As mercury cycles through the environment, it is absorbed and ingested by plants and animals. Most of the mercury absorbed will be returned to the environment but some will remain in the plant and animal tissues, where it has led to fish consumption guidelines in the Flint basin. In Spalding and Fayette Counties, there is a fish consumption guideline for largemouth bass due to mercury. In Merriwether and Pike Counties, fish consumption guidelines exist for shoal bass due to mercury.

It is not known where the mercury in fish tissue originated. Mercury may be present in fish because of the mercury content of soils in the southeast, from municipal and industrial sources, or from fossil fuel use. It is also possible that mercury contamination is related to global atmospheric transport.

4.2.4 Fecal Coliform Bacteria

Violations of the standard for fecal coliform bacteria were the most commonly listed cause of non-support of designated uses in the 1994-95 water quality assessment (35 stream and one lake segments in the Flint River Basin). Fecal coliform bacteria are monitored as an indicator of fecal contamination and the possible presence of human bacterial and protozoan pathogens in water. Fecal coliform bacteria may arise from many of the different point and nonpoint sources discussed in Section 4.1. Human waste is of greatest concern as a potential source of bacteria and other pathogens. One function of wastewater treatment plants is to reduce this risk through disinfection. Observed violations of the fecal coliform standard below wastewater treatment plants on the Flint River have generally been rapidly corrected in recent years. Combined sewer overflows, which may discharge diluted untreated wastewater directly to streams during wet weather, have been a source of intermittent fecal coliform contamination in the Albany area, but are now being addressed through control strategies, as discussed in Sections 4.1.1.2 and 7.0.

Fecal coliform data from the four EPD trend monitoring stations used in section 4.2.1 are summarized in Figures 4-28 through 4-31, and in Table 4-11. The last column of this table displays the percent of observations that fell above 400 per 100 ml; this column is useful for comparative purposes, and does not indicate the number of violations of water quality standards (which have changed over the period of record of this station). Note that the left-hand axis of the figures uses a logarithmic scale. Fecal coliform are measured as the number of cells per 100 milliliters of water. The Inman trend monitoring station (Figure 4-28) shows the effects of wastewater treatment plant effluent and runoff from the urbanized area south of Atlanta. In the early 70s, fecal coliform counts greater than 10,000 per 100 ml were not uncommon. Treatment plant upgrades and diversions (as discussed in 4.2.1) have caused observed fecal coliform counts to drop somewhat, though counts greater than 1,000 are still common on an intermittent basis in response to runoff events. This demonstrates the importance of nonpoint sources in contributing to fecal coliform levels. Fecal coliform levels near Oglethorpe (Figure 4-29) are markedly lower than at Inman, since this area is not strongly impacted by point sources or by urban runoff. The maximum observed count here is 43,000, as compared to a maximum of 11 million at the Inman station. Fecal coliform counts at the Oglethorpe station appear to be staying in about the same range for the last 15 to 20 years. The Plant Mitchell intake (Figure 4-30) is just below Albany, and the median fecal coliform count (930 per 100 ml) is evidence of the impact of point and nonpoint sources. Occasional counts greater than 100,000 are evidence of Albany's intermittent combined sewer overflows (CSOs), which discharge diluted untreated wastewater into the Flint River. Completion of controls and disinfection for Albany CSOs will reduce fecal coliform concentration peaks in this stretch of the river. The 1995-96 median count was 330, which may be an indication of a general downward trend in fecal coliform levels. The station at the top of Lake Seminole (Figure 4-31) shows lower fecal coliform counts than those below Albany, and also appears to be experiencing a downward trend.

As point sources have been brought under control, nonpoint sources have become increasingly important as potential sources of fecal coliform bacteria. In the Flint River Basin, fecal coliform concentrations have been documented in excess of water quality criteria in 35 segments (covering 356 river miles). Point source inputs were thought to be responsible in 5 of these segments (less than 70 river miles). Nonpoint sources may include:

- Agricultural nonpoint sources of fecal contamination mainly include animal operations and/or animal wastes that may enter stream systems through stormwater runoff.
- Urban nonpoint sources of fecal contamination, human and animal, are also loaded to rivers and streams through runoff. The majority of fecal coliform violations in the Flint basin are directly attributed to urban runoff.
- Urban and rural input from failed or ponding septic systems may also contribute to fecal contamination in the Flint River Basin.

4.2.5 Synthetic Organic Chemicals

Synthetic organic chemicals (SOCs) include pesticides, herbicides, and other man-made toxic chemicals. SOCs may be loaded to waterbodies in a variety of ways, including:

- Industrial point source discharges;

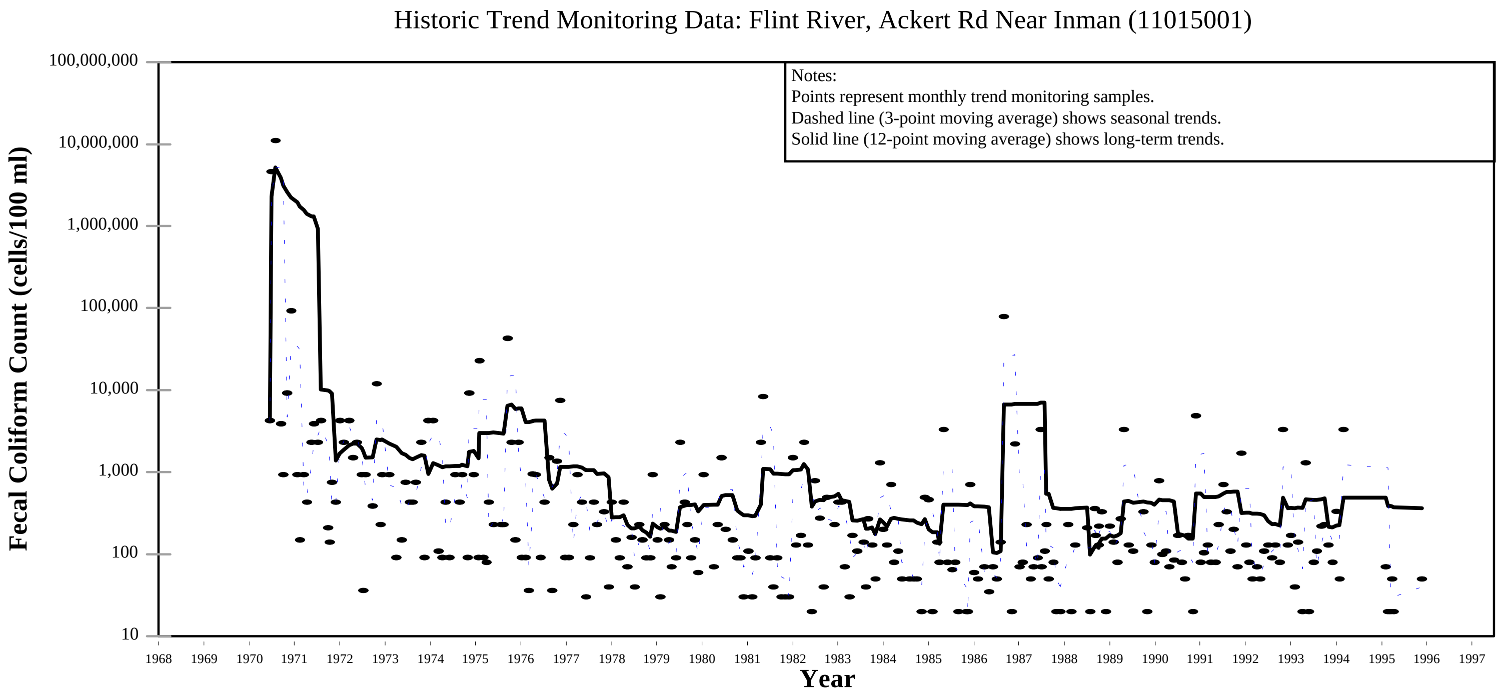

Figure 4-28. Fecal Coliform Bacteria Concentrations, Flint River near Inman, 1968-1997

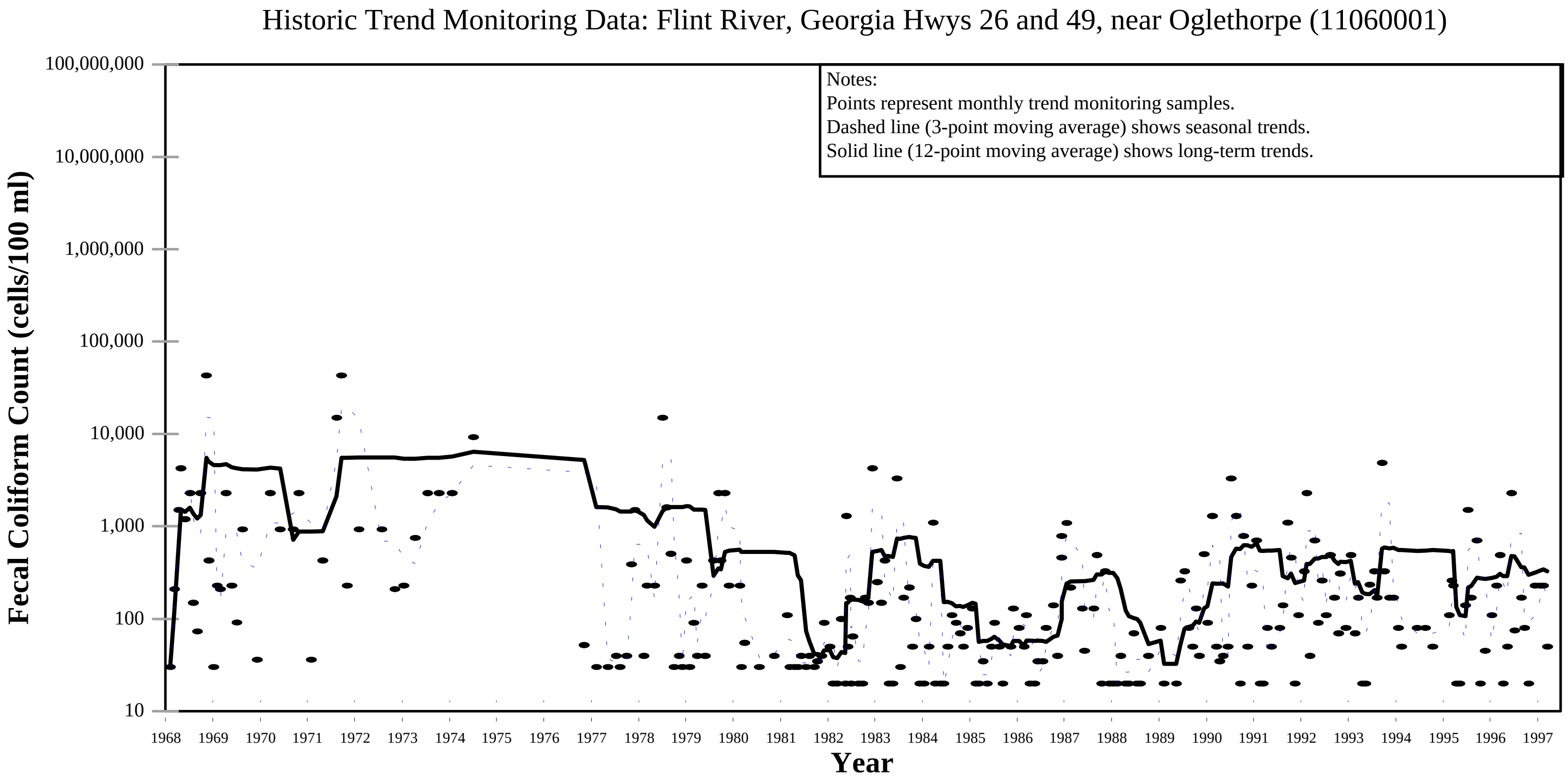

Figure 4-29. Fecal Coliform Bacteria Concentrations, Flint River near Oglethorpe, 1968-1997

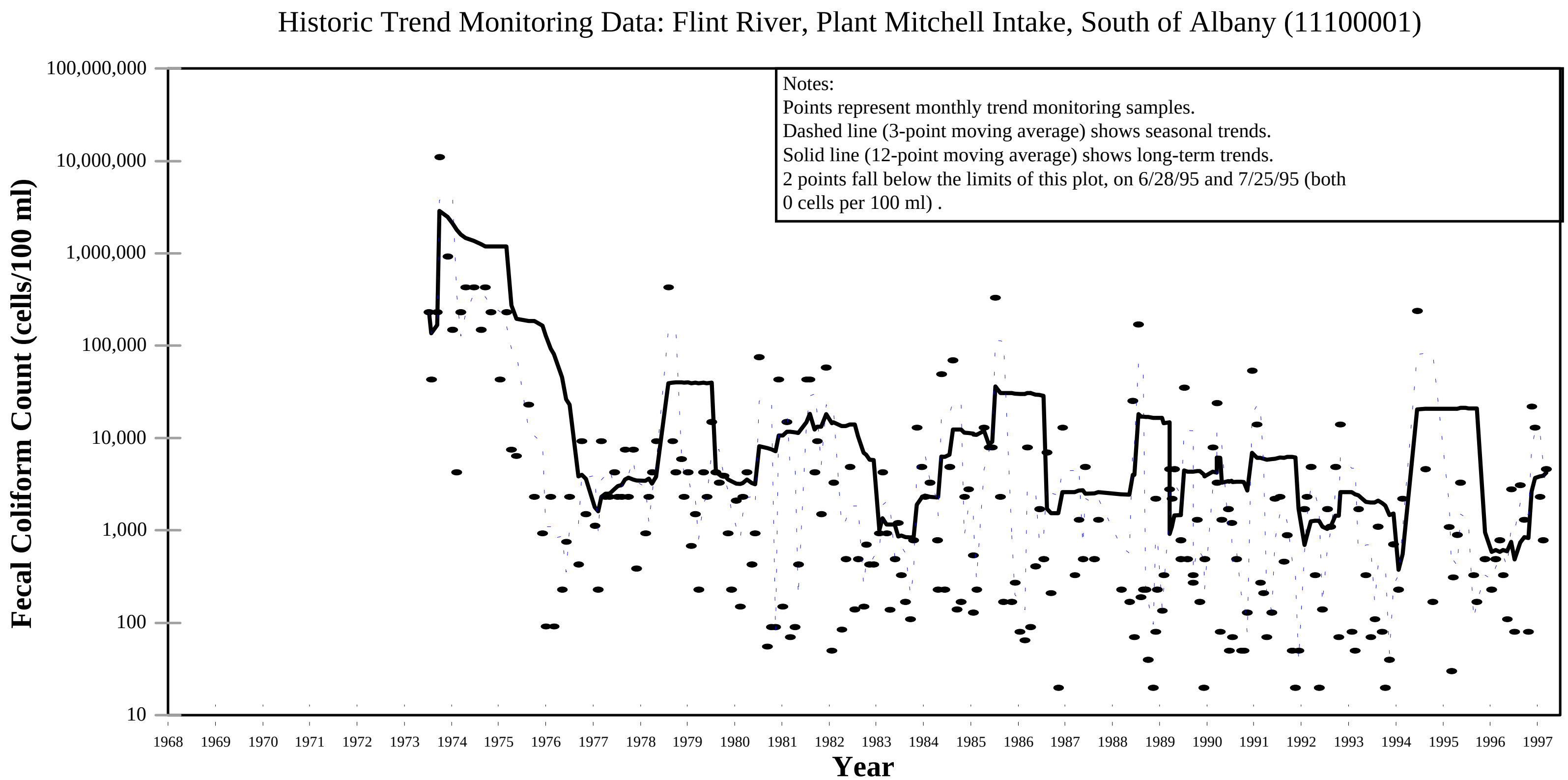

Figure 4-30. Fecal Coliform Bacteria Concentrations, Flint River, South of Albany, 1968-1997

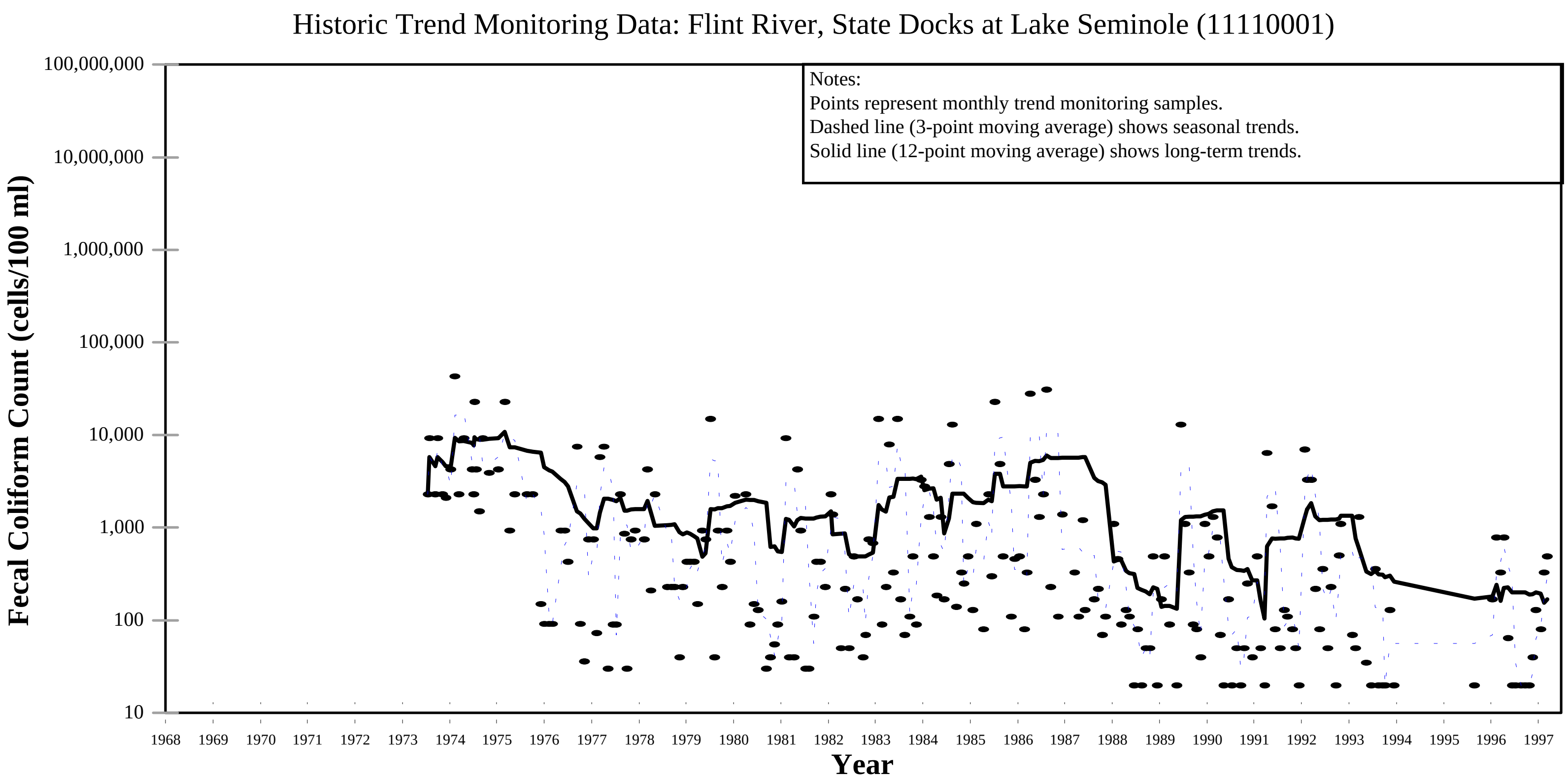

Figure 4-31. Fecal Coliform Bacteria Concentrations, Flint River, State Docks at Lake Seminole, 1968-1997

Table 4-11. Summary of Fecal Coliform Count Data in Flint River Mainstem, 1968-1997

Station	Fecal Coliform Count (MPN/ml)			Percent Above 400
	Max (Year)	Median	1995-96 Median	
Ackert Road near Inman	11,000,000 (1970)	140	<35	30.8
Georgia Highways 26 and 49 near Oglethorpe	43,000 (1971)	90	125	23.4
Plant Mitchell Intake south of Albany	11,000,000 (1973)	930	330	64.2
State Docks at Lake Seminole Inflow	43,000 (1974)	250	40	45.1

- Wastewater treatment plant point source discharges, which often include industrial effluent as well as SOCs from household disposal of products such as cleaning agents, insecticides, etc.;
- Nonpoint runoff from agricultural and silvicultural land with pesticide and herbicide applications;
- Nonpoint runoff from urban areas, which may load a variety of SOCs, including horticultural chemicals, termiticides, etc.;
- Illegal disposal and dumping of wastes.

To date, synthetic organic chemicals have not been detected in surface waters of the Flint River Basin in problem concentrations. Agricultural sources were potentially important in the past, particularly from cotton production in the Coastal Plain, but risk of excess loading has apparently declined with the switch to less persistent pesticides. Recent research by USGS (Stell et al., 1995; Hippe et al., 1994) suggests that pesticide/herbicide loading in urban runoff may be of greater concern than agricultural loading, particularly in streams of the metropolitan Atlanta and Albany areas.

Certain SOCs, discharged to the watershed in past decades, continue to be of concern today. These compounds, which are highly bioaccumulative, apparently continue to enter the food chain through contaminated sediments. Urban runoff and stormwater may also play a role in continued loading of these chemicals. PCBs and chlordane, which have been banned, cause fish consumption guidelines in many areas in Georgia. The Flint River, however, contains no fish consumption guidelines for either PCBs or chlordane.

4.2.6 Stream Flow and Flooding

One of the main issues concerning stream flow in the Flint River Basin is directly related to groundwater withdrawals and input. Many groundwater springs exist in the lower half of the basin and greatly contribute to stream flow, especially during long periods of dry weather. As ground water pumping is increased for crop irrigation, the base flow contribution to the stream flow will decrease.

Flooding is another major concern facing the Flint River Basin, as demonstrated during Tropical Storm Alberto, July 3-7, 1994. This storm dropped as much as 28 inches of rain onto parts of southwestern and central Georgia, causing severe flooding on the Flint River and several of its tributaries. This storm generated over 7 inches of runoff (700 billion gallons) in the Flint River Basin upstream of Newton. The flooding associated with Tropical Storm Alberto caused severe damage to both the Flint River and Warwick dams.

4.2.7 Sediment

Erosion and discharge of sediment can have a number of adverse impacts on water quality. First, sediment may carry sorbed nutrients, pesticides and metals into streams. Second, sediment is itself a stressor. Excess sediment loads can alter habitat, destroy fish spawning substrate, and choke aquatic life, while high turbidity also impairs recreational and drinking water uses. It can interfere with the photosynthetic process by reducing light penetration. Deposits may also fill reservoirs and hinder navigation. Important sources of sediment load include: construction; unpaved rural roads; streambank erosion associated with peak flows from increased impervious area and hydropower operations; dredging; agriculture; and forestry.

Sediment loading is of concern throughout the Flint basin, but is of greatest concern in developing areas of metropolitan Atlanta and in lower half of the basin where agriculture is predominant.

4.2.8 Habitat Degradation and Loss

Chemical and organic pollution are commonly perceived as the greatest threats to aquatic ecosystems, and are of primary concern to human health and water quality monitoring programs. However, a recent international study determined that habitat loss and degradation, as well as overharvesting are significant factors contributing to species population declines and extinctions. For example, both the alligator snapping turtle and Barbour’s map turtle are endangered as a consequence of overharvesting. Many of the basin’s fish and mussel species are threatened primarily as a result of habitat loss due to reservoir construction and sedimentation. A 1993 survey by the U.S. Fish and Wildlife Service found severely declining populations of all unionid mussel species in the Flint River (Couch et al., 1996).

In many parts of the Flint basin, support for native aquatic life is threatened by degradation of aquatic habitat. Habitat degradation is closely tied to sediment loading, and excess sediment is the main threat to habitat in rural areas with extensive land disturbing activities, as well as in urban areas where increased flow peaks and construction can choke and alter stream bottom substrates. A second important type of habitat degradation in the Flint is loss of riparian tree cover, which can lead to increased water temperatures.

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